

Banking development, income, and environmental degradation in the UAE. Novel empirical evidence from a bootstrap ARDL test

Yazan Qashou,¹ Ahmed Samour,² Mohammed Abumunshar³

¹ Economics Department. Near East University, TRNC Mersin 10 – Turkey.

² Banking and Finance Department. Near East University, TRNC Mersin 10 – Turkey.

³ Accounting and Finance Department. Cyprus International University, TRNC Mersin 10 – Turkey.

1, yazanqashou6@hotmail.com

2, ahmad.samour@neu.edu.tr

3, mohammad.abumonshar31@gmail.com

Phone: +90 54 2888 94 58

ABSTRACT

The present work explores the impact of energy, financial sector development, and income on the UAE's environmental degradation. The ARDL, DOLS, CCR, and FMOLS approaches are employed to explore a long-run link among the examined variables. To present novel evidence to the empirical literature, the present work utilizes the updated method of ARDL approach as introduced by (McNown et al. 2018), and new method of Bayer and Hanck as introduced by Bayer and Hanck (2013). The coefficients of tested models illustrate that real income positively affected the level of environmental degradation in the UAE. Moreover, the outcomes demonstrated that the development of the financial sector has a significant influence on the level of environmental quality in the UAE. Furthermore, the outcomes show that nonrenewable energy positively affects ecological pollution. The results of the present research provide valuable findings for the UAE's policymakers heading to sustainable banking and energy sector. It suggested that the government should use the significant growth of the banking sector to support and improve the environmental quality

Keywords: UAE, Banking sector development, environmental degradation, Bayer and Hanck, Bootstrap ARDL

Mathematics Subject Classification: 28-XX, 62P20

1. Introduction

The United Arab Emirates is a highly developed economy based on its gross domestic product (GDP). The GDP growth in the UAE represents one of the fastest-growing economies in emerging economies, which significantly increased from 50 billion US dollars(USD) in 1990 to 417 billion USD in 2019. On the other hand, carbon emissions decreased from 30 metric tons per capita in 1990 to 21 metric tons per capita in 2019. The UAE is still facing climate change challenges. This gets along with

the objective of the present study, which is to explore the influence of energy, income, and financial sector development on the level of environmental pollution over the period 1990 to 2019. In the existing empirical studies, several studies tested the determinants of the level of environmental degradation (Altarhouni et al.,2021; Abumunshar et al.,2020; Samour et al.,2021). In comparison, few studies investigated the effect of banking sector growth on environmental pollution. In this context, Samour et al. (2021) explored the role of banking growth on environmental degradation in Turkey, Obiora et al.,(2020) investigated the long-term viability of the environment as a result of banking expansion. Limited papers have been undertaken on the impact of banking expansion on the consumption of energy, as we have done in this research. However, the present study is the first to estimate the effect of tested variables on the level of environmental pollution in the UAE using B-ARDL. The new test of ARDL as proposed by McNown et al. (2018) is desired over traditional Pesaran (2001) co-integration tests due to its advantage to estimate when resolving limitation of size issues, which have not been addressed by traditional co-integration tests.

The banking sector of the United Arab Emirates (UAE) has undergone positive improvements during the last decades. In this pursuit, the total credit from the banking sector to the private sector as a percentage of gross domestic products (GDP) in 2018 rose to around 74% in 2018 compared to 30 %in 1988. On the other hand, rising natural gas prices in the UAE over the last years have combined with the rapidly falling renewable energy system's cost, including the solar photovoltaic systems. This in turn, leads to the use of more sources of renewable energy for power production, ramping up renewables to 30% of total power generation, could generate annual savings of four billion US dollars by 2030 through avoidance of the consumption of nonrenewable energy and lower energy cost. With environmental and financial benefits factored in the transition to renewables, the country targets to reach 44% of the installed capacity with clean resources in 2050. However, the banking sector growth offers cheaper loans to the producer, and then they purchase advanced raises consumption of energy. On the other hand, banking sector growth may affect the consumption of energy through other economic channels such as economic growth and investments. For instance, financial sector growth provides funds for the investors, which leads to boost total factor productivity, capital accumulations and promoting total factor productivity cause to increase economic growth, and this may lead to increase the consumption of the energy and CO₂ emission. This study suggests the influence of banking sector growth on the environment depends on how this variable affects economic growth. In this respect, any improvement in the financial sectors, such as an increase in the credits from the banks to the markets may lead to boots in the projects and investment and improve the risk management systems, which may lead to affect economic growth and consumption of energy; hence, it may lead to increase environmental degradation.

By assessing the impact of banking sector growth on the environmental quality, the existing paper will determine the role of the banking sector in the ecological quality issues; in fact, the banking sector has a crucial role in attaining economic and financial stability through credit that provided to banks and markets. The banking sector should use this credit to enhance the production and investment in

renewables. In this context, the main objective of this study is to test the impact of banking sector expansion on the level of environmental degradation in the UAE.

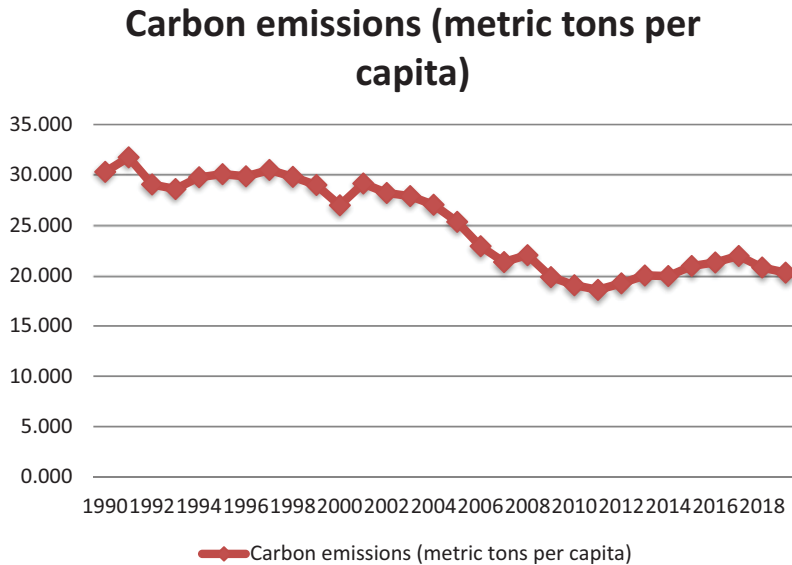


Figure 1. Carbon emissions in UAE over the period from 1990-2019

The following sections of the current paper illustrate the review of the literature (section 2), empirical model, methodology (section 3), the empirical outcomes (section 4), and the final conclusion of our work (section 5).

2. Review of the empirical literature

Several empirical in the literature illustrated that financial development affected the level of environmental pollution. In this context, Zhang(2011) tested the impacts of financial sector growth on the levels of nonrenewable energy consumption (NREC) and environmental pollution in China. The authors affirmed that financial expansion positively affected NREC and environmental pollution. Al-Mulali and Lee (2013) applied the DOLS approach and confirmed that financial sector growth positively affected the level of environmental pollution in the MENA region. Sbia et al. (2015) provided empirical evidence that financial sector growth positively affected ecological pollution in India during the period from 1970 to2012. Pata(2018) used the ARDL model and examined the financial sector's influence on the environmental pollution level in Turkey. The outcomes reported a positive link between the growth of the financial industry and the level of environmental pollution. Haseeb et al. (2018) illustrated a positive connection between the expansion of the financial sector and the carbon levels in India, South Africa, Russia, and China. However, these studies suggested that financial development positively affected economic growth, which in turn led to a rise in the utilization of energy and carbon levels. However, there are limited studies that tested the impact of banking development on environmental pollution. In this context, Samour et al. (2021) explored the role of banking sector

development on the level of ecological degradation in Turkey, Obiora et al. (2020) investigated the long-term viability of the environment as a result of banking development. It is apparent that limited studies have been undertaken on the impact of banking expansion on the consumption of energy, as we have done in this research

On the other hand, several empirical studies examined the connections between NREC, economic growth, and environmental quality. In this context, Samour et al. (2021) used the ARDL model and illustrated that NREC negatively links ecological pollution. Similar results were found by Abumunshar et al. (2020), Altarhouni et al. (2021), who confirmed that real income positively affected the level of environmental pollution in Turkey. Bento and Moutinho (2016) illustrated that NREC positively affects the level of environmental pollution. In contrast, the results found that nonrenewable energy is significant and positively affects CO₂ emissions. Shafiei and Salim (2014) demonstrated a negative association amongst environmental degradation in the OECD countries. Chen and Geng (2016) also confirmed that nonrenewable energy in 30 OECD countries positively affected ecological pollution. Doğan and Öztürk (2017) used the ARDL model and affirmed that NREC positively affected the level of environmental degradation. In the UAE, Al-mulali and Che(2018), who used the vector autoregressive model, and found that NREC has a positive influence on the UAE's emissions levels, Panigrahi et al. (2020), who used the period from 1991-to 2021, affirmed that NREC affected emissions positively in UAE. Sbia et al. (2014) used ARDL testing and approved that the ECK approach is valid. Similarly, Charfeddine and Khediri (2016) supported that the ECK approach was correct in the UAE from 1975 to 2011.

3. Model, Data, and Methodology

In the current study, economic growth (GDP), nonrenewable energy consumption (NREC), banking sector development (BSD) are the main determinants of carbon emissions. Thus, the studied model is formulated in the next formula:

$$CO_2=f(GDP, BSD, NREC) \quad (1)$$

The assumption is that environmental pollution is measured by carbon emissions and regressed of NREC, BSD, GDP. CO₂ is the carbon dioxide emissions, GDP is the economic growth in the UAE, NREC represents consumption of nonrenewable energy in the UAE over the tested period. Thus, the tested model can be formulated as follow:

$$\ln CO_{2t} = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \ln BSD_t + \beta_3 \ln NREC_t + \epsilon \quad (2)$$

where $\ln CO_2$ is the carbon-emissions in "kilotons", $\ln GDP$ is the (GDP) in constant 2010 US-dollars, $\beta_2 \ln BSD_t$ is banking sector development index measured and determined by credits from banks to markets as a % of GDP in the UAE, $\ln NREC$ is of consumption of nonrenewable energy in log. The

tested data of the current research is obtained from the World Bank Development Indicators (World Bank). The data retrieved is yearly data and ranges from 1990-2019.

3.1 Stationary and co-integration tests

To check the co-integration amongst the selected variables, the paper uses unit root tests with break dates (B-D) such as Zivot-Andrews (ZA) (2002), Perron-Vogelsang (PV) (1999) tests with one date of structural change. To check the long-run link amongst the BSD, GDP, NREC, CO₂, the study uses ARDL testing. Unlike other estimating approaches, this model examines if there is co-integration among the variables in three cases I(1), or I(0) or in both of them.

Recently, this model was updated and improved; the updated method combines additional t-test $t_{dependent}$ or F-test $F_{independent}$ on lagged studied variables. The H_0 of $t_{dependent}$ test is: $\sigma_1 = 0$. The H_1 of $t_{dependent}$ test is: $\sigma_1 \neq 0$. Whereas, the H_0 of $F_{independent}$ test is: $H_0: \sigma_2 = \sigma_3 = \sigma_4 = 0$. The H_1 of $F_{independent}$ test is: $H_1: \sigma_2 \neq \sigma_3 \neq \sigma_4 \neq 0$.

The (CV) in the new model of the ARDL testing is based on particular level of integration for each studied variable, which will affirm the findings of the ARDL (2001) test. The CV, as presented by Pesaran et al. (2001) allow only for (one) selected variable to be endogenous. While the CV of the new method of ARDL allow for all tested variable to be endogenous.

The study employed the ARDL approach to test the connection amongst the tested variables in the short and long run.

The testing of the ARDL model of BSD, NREC, GDP, and CO₂ emissions is formulated in the next formula:

$$\Delta \ln CO_{2t} = \beta_0 + \sum_{i=1}^n \gamma_1 \Delta \ln CO_{2t-i} + \sum_{i=1}^n \gamma_2 \Delta \ln GDP_{t-i} + \sum_{i=1}^n \gamma_3 \Delta \ln BSD_{t-i} + \sum_{i=1}^n \gamma_4 \Delta \ln NREC_{t-i} + \sigma_1 \ln CO_{2t-1} + \sigma_2 \ln GDP_{t-1} + \sigma_3 \ln BSD_{t-1} + \sigma_4 \ln NREC_{t-1} + \varepsilon_{1t} \quad (3)$$

where Δ means the first difference operator, $\ln CO_{2t}$ is the logarithm of the dependent variable, $\ln GDP$, $\ln BSD$, $\ln NREC$ are the independent tested variables in log; n is the lags optimal; and ε_{1t} represents the error-term. The ECM is formulated by the equation(4) to estimate the speed level of adjustment:

$$\Delta \ln CO_{2t} = \beta_0 + \sum_{i=1}^n \beta_1 \Delta \ln CO_{2t-i} + \sum_{i=1}^n \beta_2 \Delta \ln GDP_{t-i} + \sum_{i=1}^n \beta_3 \Delta \ln BSD_{t-i} + \sum_{i=1}^n \beta_4 \Delta \ln NREC_{t-i} + ECT_{t-1} + u_t \quad (4)$$

where Δ is a change in $\ln CO_{2t}$, $\ln GDP$, $\ln BSD$, $\ln NREC$, and ECT_{t-1} is error correction-term. In addition, the Bayer and Hanck(2013) approach is utilized to confirm the ARDL of the co-integration

method. The core advantage of this approach is that it combines (four) co-integration techniques, namely: (1) Banerjee et al. (1998), (2) Banerjee et al. (1998), (3) Johansen (1988), (4) Engle and Granger(1987). Besides, this method includes the *Fisher (F)* statistics to enhance the findings of the co-integration. This approach is formulated in the following formulas:

$$EGt - JOHt = -2[IN(P_{EGt}) + (P_{JOHt})] \quad (5)$$

$$EGt - JOHt - BOt - BDMt = -2[IN(P_{EGt}) + (P_{JOt}) + (P_{BOt}) + (P_{BAT})](6)$$

In order to promote the results of the ARDL approach, the present research uses CCR, FM-OLS, and D-OLS to approve the results of ARDL testing. To affirm the present study has a normal distribution, there is no-autocorrelation, the R-Reset, LM, ARCH Breusch-Pagan Godfrey, and Normality tests were applied.

4. Findings and Discussions

The (ZA) and (PV) unit root tests with one SBD are illustrated in Tables 1 and 2; these tests suggest one and two structural breaks dates (SBD) in the explored variables. It was shown by these unit root tests that all the variables of this study are non-stationary at level, but they are stationary at the first difference. However, the results of the ZA and PV tests illustrated that $\ln CO_2$, $\ln GDP$, $\ln BSD$, and $\ln NREC$ variables have $I(1)$ order of integration.

Table 1. The outcomes of ZA test

At-level			At Δ		
Variables	t-stat	SBD	Variables	t-stat	SBD
$\ln CO_2$	-1.003	1999	$\Delta \ln CO_2$	-6.764**	2002
$\ln GDP$	-1.967	2008	$\Delta \ln GDP$	-6.131**	2009
$\ln BSD$	-0.258	1990	$\Delta \ln BSD$	-5.385**	2005
$\ln NREC$	-1.251	2000	$\Delta \ln NREC$	-6.445**	2008

**means the significance of variables at 5%.

Table 2 The outcomes of PV test

At level			At Δ		
Variables	t-statist	SBD	Variables	St-stat	BD
$\ln CO_2$	-2.459	2001	$\Delta \ln CO_2$	-7.444**	2001
$\ln GDP$	-1.785	2008	$\Delta \ln GDP$	-8.996**	2008
$\ln BSD$	-1.003	2009	$\Delta \ln BSD$	-7.480**	1998
$\ln NREC$	-1.115	1998	$\Delta \ln NREC$	-7.661**	2010

**means significance of variables at 5%.

The results of the bootstrap ARDL testing are displayed in Table 3. The results affirm the co-integration amongst $\ln CO_2$, $\ln GDP$, $\ln BSD$, and $\ln NREC$ is valid. Besides, the outcomes of the BH

testing as shown in Table4 illustrate that the values of F -statistics are higher than F -statistics in the four co-integration tests "EGT-JOT" and "EGT-JOT- BOT-BAT" at 5% significant level. This finding approves that the level of co-integration among tested variables is valid.

Table 3 The outcomes of Bootstrap ARDL test

ARDL(1,1,0,1)		$F_{Pesaran}$	$t_{dependent}$	$F_{independent}$
(CO ₂ , GDP, BSD, NREC)		5.712***	-4.99***	7.82***
Bootstrap-based table CV	1%	3.89	-3.78	7.00
	5%	3.11	-3.07	4.45
	10%	2.85	-2.05	3.86

***statistical sign at 1% level.

Table 4 Results of BH test

<i>Fisher – statistics</i>		
	EGT.JOT	EGT/JOT/BOT/BAT
	16.669**	23.210 **
Significantly level at (5%)	10.419	19.888

Note: ** symbolize to significantly level at 5%

The coefficients in the long run from the ARDL tested model are displayed in Table 5. The findings illustrated the coefficient of GDP is positive and significant. These results demonstrated that a one percent increase in GDP causes a substantial increase in the level of environmental pollution in the UAE with 2.4% and 4.8% in the short and long-run, respectively. The DOLS, CCR, and FMOLS are displayed in Table 5. The coefficients of GDP in these models are positive and significant. However, the findings from ARDL, FMOLS, and CCR estimating models approve that the positive increase in the level of economic growth significantly increases the level of environmental pollution. These findings are in line with Shahbaz et al. (2015) who used ARDL testing and approved that GDP affected positively the level of carbon emissions in the UAE, and Charfeddine and Khediri (2016) who approved that GDP affected the level of environmental pollution over the period from 1975 to 2011 positively.

Furthermore, the findings from the ARDL testing model in the long run illustrated that the coefficient of NREC is positive and significant. These outcomes display that a one percent increase in NREC causes a considerable increase in the environmental pollution in the UAE with 1.10% and 1.01% in the short and long-run, respectively. The coefficients of NREC in FMOLS, DOLS, and CCR models are positive and significant. The findings from ARDL, DOLS, FMOLS, and CCR estimating models approve that the positive increase in the level of NREC significantly increases the level of environmental pollution. These findings are in line with Al-mulali and Che(20218) who used the vector autoregressive model, and found that NREC has a positive influence on the UAE's emissions

levels, Panigrahi et al.,(2020) who used the period from 1991-2021, affirmed that NREC affected emissions positively in UAE.

On the other hand, the findings from the ARDL testing model in the long run illustrated that the coefficient of BSD is positive and significant. These outputs illustrated that a one percent increase in banking sector development causes a significant increase in the level of environmental pollution in the UAE with 0.010% and 0.193% . The coefficients of BSD in FMOLS, DOLS, and CCR models are positive and significant. However, the findings from ARDL, DOLS, FMOLS, and CCR estimating models approve that the positive increase in the level of BSD significantly increases the level of environmental pollution. These results can be explained that the banking sector growth offers cheaper loans to the producer, then they purchase advanced raises energy consumption. On the other hand, banking sector growth may affect energy consumption through other economic channels such as economic growth and investments. For instance, financial sector growth provides funds for the investors, which leads to boost total factor productivity, capital accumulations and promoting total factor productivity cause to increase economic growth, and this may lead to increase the consumption of the energy and carbon emission.

Table 5 Findings of ARDL, D-OLS, FM-OLS,CCR models

Variable	ARDL	D-OLS	FM-OLS	CCR
LnGDP	2.410**	2.001**	1.910	2.210**
lnBSD	0.010*	0.020**	0.031**	0.002**
lnNREC	1.010***	1.008***	1.991*	1.881***
R ²	0.98	0.96	0.95	0.96

*, **, *** means significance of variables at 10%, 5%, 1% levels.

The outcome of ECM is displayed in Table 6. The ECM is -0.611, which is statistically significant and negative. To affirm that the tested model of the present research is formulated correctly, the study employs the *Normality, Breusch – Pagan Godfrey, ARCH, LM, and Ramsey – Reset tests*. The outcomes of these tests affirm that the studied model is correct and stable. Furthermore, the results display that the model of the present research is typically distributed, and there is no auto-correlation. In addition, Figures 1 and 2 affirm that the tested model of the present study is correct.

Table 6 ARDL results in the short-run

Variable	Coeff.	t-statistics
$\Delta \ln \text{GDP}$	4.810***	-8.991
$\Delta \ln \text{BSD}$	0.193***	1.004
$\Delta \ln \text{NREC}$	1.108***	2.881
ECT_{t-1}	-0.611	-1.910

Note: *** indicates the significance of variables at 1% level

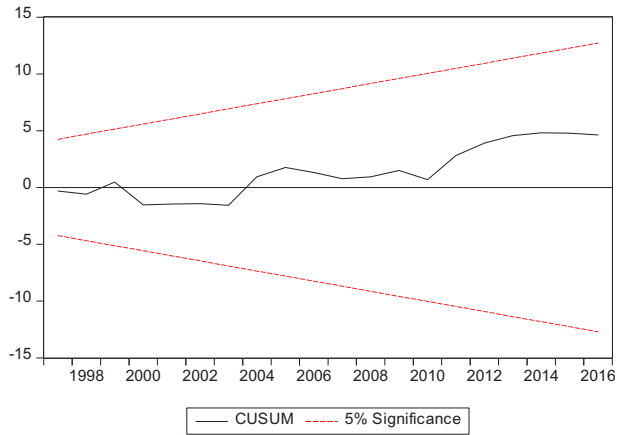


Figure 1. Cusum test

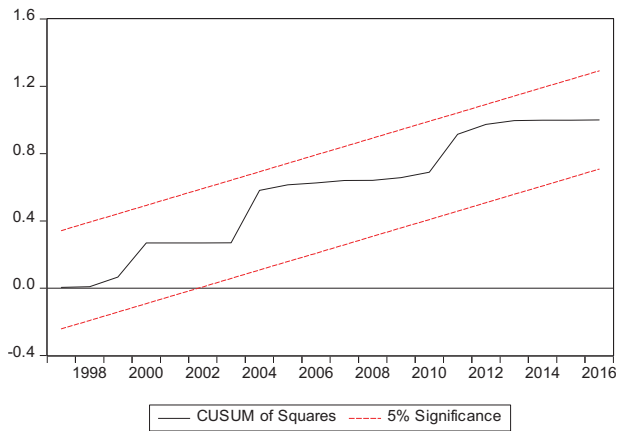


Figure 2. Cusum Squares test

Table 7: Diagnostic test results for ARDL

Test	P/value
–Serial correlation (LM)	1.991(0.661)
–Heteroscedasticity	0.521(0.810)
–Normality test	1.441(0.210)
–ARCH Test	1.002(0.310)
–Stability Ramsey test	1.210(0.510)

The empirical results confirm a positive impact of banking development on renewable energy consumption levels in the UAE over the tested period. Consequently, any increase in credit from banks to markets will lead to a rise in projects and investment, as well as strengthen risk management systems, potentially affecting economic growth, which consequently leads to an increase in the share of renewable energy consumption. Hence, the outcome recommends that the policymakers in the country must use the banking development to enhance green energy investments. As a result, the

findings of this article present valuable recommendations for the policymakers in the UAE to strengthen sustainable development by diversifying its energy mix and promoting green investment.

5. Conclusion

The United Arab Emirates (UAE) banking sector has undergone positive improvements during the last decades. In this pursuit, the total credit from the banking sector to the private sector as a percentage of gross domestic products (GDP) in 2018 rose to around 74% in 2018 compared to 30 %in 1988. On the other hand, increasing natural gas prices in the UAE over the last years have combined with the rapidly falling renewable energy system's cost, including the solar photovoltaic systems. This in turn leads to the use of more renewable energy sources for power production, ramping up renewables to 30% of total power generation, could generate annual savings of four billion US dollars by 2030 through avoidance of the consumption of nonrenewable energy and lower energy cost. With environmental and financial benefits factored in the transition to renewables, the country targets to reach 44% of the installed capacity with clean resources in 2050.

On the other hand, the UAE is still facing the climate change challenge. For these reasons, using ARDL, FM-OLS, CCR, D-OLS, CCR, the present research aims to test the impact of banking development, income, NREC on the level of carbon emission in the UAE over the period from 1990-2019. In the current literature, there are limited studies that test the impact of banking development on environmental pollution levels. In this context, Samour et al. (2019) and Obiora et al. (2020) investigated the long-term viability of the environment and banking development. Few studies have been undertaken on the influence of banking expansion on the level of energy consumption, as we have done in this research. However, the present research is the first to test the impact of tested variables on the level of carbon emissions in the UAE using B-ARDL. The new test of ARDL as proposed by McNown et al. (2018) is desired over traditional Pesaran (2001) co-integration tests due to its ability to estimate when resolving the limitation issues of size, its corresponding features, which have not been addressed by traditional co-integration tests.

The finding from ARDL, D-OLS, CCR, and FM-OLS illustrated that economic growth positively affected the level of environmental pollution in the UAE over the tested period. Furthermore, the findings affirmed that NREC positively affected the level of carbon emission in the UAE in both the short and long run. On the other hand, the results established that the banking sector positively influences the environmental degradation level in the UAE. However, the study demonstrates that more income, energy consumption, and credit will lead to further environmental degradation in UAE. The study suggests that the governments of the UAE should design policies to reduce the costs of renewable resources, and the policymakers in the UAE should promote the role of green energy and reduce the level of oil consumption, which can be considered an excellent solution to reduce the carbon emissions.

However, the empirical findings of this study present the need for strategies that support the share of green energy usage in the total energy mix of UAE to decrease the levels of carbon emissions. Some

of these strategies include enhancing the execution of carbon tax laws. Energy strategies should target boosting the ability of households and investors to enable them to embrace new and green energy sources in their homes and business. In this instance, policymakers should establish a favorable environment such that investors and households can access cleaner energy. Furthermore, policymakers should encourage trade and investment in green energy sources by removing trade barriers and assuring investor confidence by minimizing trade conflicts between the local community and investors, and ensuring energy investment assurance. As a consequence, any increase in credit from banks to markets will lead to a rise in projects and investment, as well as strengthen risk management systems, potentially affecting economic growth and oil consumption and therefore increasing CO₂ emissions. Hence, the outcome suggests that policymakers in UAE must use the growth of the banking sector to minimize environmental degradation by promoting investment in energy and production through renewable energy sources. The outcomes of the present article introduce significant conclusions for UAE policymakers to achieve a sustainable banking sector by enhancing renewable energy use.

REFERENCES

- Abumunshar, M., Aga, M., & Samour, A. (2020). Oil Price, Energy Consumption, and CO₂ Emissions in Turkey. New Evidence from a Bootstrap ARDL Test. *Energies*, 13(21), 5588.
- Al-Mulali, U., Fereidouni, H. G., Lee, J. Y., & Sab, C. N. B. C. (2013). Exploring the relationship between urbanization, energy consumption, and CO₂ emission in MENA countries. *Renewable and Sustainable Energy Reviews*, 23, 107-112.
- Altarhouni, A., Danju, D., & Samour, A. (2021). Insurance Market Development, Energy Consumption, and Turkey's CO₂ Emissions. New Perspectives from a Bootstrap ARDL Test. *Energies*, 14(23), 7830.
- Banerjee, A., Dolado, J., & Mestre, R. (1998). Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of time series analysis*, 19(3), 267-283.
- Bayer, C., & Hanck, C. (2013). Combining non-cointegration tests. *Journal of Time series analysis*, 34(1), 83-95.
- Bento, J. P. C., Moutinho, V., 2016, CO₂ emissions, non-renewable and renewable electricity production, economic growth, and international trade in Italy, *Renewable and Sustainable Energy Reviews*, 55, 142-155.
- Boswijk, H. P. (1994). Testing for an unstable root in conditional and structural error correction models. *Journal of econometrics*, 63(1), 37-60.
- Charfeddine, L., & Khediri, K. B. (2016). Financial development and environmental quality in UAE: Cointegration with structural breaks. *Renewable and Sustainable Energy Reviews*, 55, 1322-1335.
- Chen, W., & Geng, W. (2017). Fossil energy saving and CO₂ emissions reduction performance, and dynamic change in performance considering renewable energy input. *Energy*, 120, 283-292.

- Dogan, E., & Ozturk, I. (2017). The influence of renewable and non-renewable energy consumption and real income on CO₂ emissions in the USA: evidence from structural break tests. *Environmental Science and Pollution Research*, 24(11), 10846-10854.
- Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.
- Erdogan, S., Akalin, G., & Oypan, O. (2020). Are shocks to disaggregated energy consumption transitory or permanent in Turkey? New evidence from fourier panel KPSS test. *Energy*, 197, 117174.
- Haseeb, A., Xia, E., Baloch, M. A., & Abbas, K. (2018). Financial development, globalization, and CO₂ emission in the presence of EKC: evidence from BRICS countries. *Environmental Science and Pollution Research*, 25(31), 31283-31296.
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, 12(2-3), 231-254.
- McNown, R., Sam, C. Y., & Goh, S. K. (2018). Bootstrapping the autoregressive distributed lag test for cointegration. *Applied Economics*, 50(13), 1509-1521.
- Pata, U. K. (2018): Renewable energy consumption, urbanization, financial development, income and CO₂ emissions in Turkey: Testing EKC hypothesis with structural breaks. – *Journal of Cleaner Production* 187: 770-779.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, 16(3), 289-326.
- Samour, (2021). Financial sector development, energy consumption, and CO₂ emission in Turkey. Fresh evidence from a new combined co-integration and Bootstrap ARDL tests. *International journal of ecological economics & statistics*. 1, 1-12.
- Obiora, S. C., Bamisile, O., Opoku-Mensah, E., & Kofi Frimpong, A. N. (2020). Impact of Banking and Financial Systems on Environmental Sustainability: An Overarching Study of Developing, Emerging, and Developed Economies. *Sustainability*, 12(19), 8074.
- Sbia, R., Shahbaz, M., & Hamdi, H. (2014). A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. *Economic modelling*, 36, 191-197.
- Shafiei, S., Salim, R. A., 2014, Non-renewable and renewable energy consumption and CO₂ emissions in OECD countries: A comparative analysis, *Energy Policy*, 66, 547-556.
- Shahbaz, M., Mallick, H., Mahalik, M. K., & Loganathan, N. (2015). Does globalization impede environmental quality in India?. *Ecological Indicators*, 52, 379-393
- Zhang, Y. J. (2011). The impact of financial development on carbon emissions: An empirical analysis in China. *Energy Policy*, 39(4), 2197-2203.
- Panigrahi, S. K., Azizan, N. A. B., & Kumaraswamy, S. (2020). Investigating dynamic effect of energy consumption, foreign direct investments and economic growth on CO₂ emissions between Oman and United Arab Emirates: evidence from Co integration and causality tests. *International Journal of Energy Economics and Policy*, 10(6), 288.