JOEEP

e-ISSN: 2651-5318
Homepage: http://dergipark.org.tr/joeep

Araştırma Makalesi ● Research Article

An Empirical Study on the Impact of Urbanization on Environmental Quality in Turkey*

Türkiye'de Kentleşmenin Çevresel Kalite Üzerindeki Etkisine Yönelik Ampirik Bir Çalışma

Emrah Sofuoğlu [a, **], Adem Alver [b] & Nagihan Bozali [c]

a, Dr., Kırşehir Ahi Evran University, Faculty of Economic and Administrative Sciences, Department of Economics, 40100, Kırşehir / Turkiye
ORCID: 0000-0001-7716-1599
b, Ra., Kırşehir Ahi Evran University, Faculty of Economic and Administrative Sciences, Department of Economics, 40100, Kırşehir / Turkiye
ORCID: 0000-0001-6799-6840
c, Uzm.Yard., Karatekin University, Institute of Social Sciences, Department of Economics, 18200, Çankırı / Turkiye
ORCID: 0000-0002-6334-2097

MAKALE BİLGİSİ

Makale Geçmişi:
Başvuru tarihi: 24 Kasım 2022
Düzeltme tarihi: 28 Mart 2023
Kabul tarihi: 19 Haziran 2023

Anahtar Kelimeler:
Kentleşme
Çevresel Kalite
Sürdürülebilir Kalkınma

ÖZ

Kentleşme ve çevre arasındaki ilişki son zamanlarda birçok araştırmacının ilgisini çekmektedir. Birçok ülkede kentleşmenin neden olduğu ek enerji tüketimi CO2 emisyonlarını artırmakta ve çevre kirliliğine yol açmaktadır. Bu çalışma, 1970-2020 döneminde Türkiye'de kentleşmenin çevre kalitesi üzerindeki etkisini test etmeyi amaçlamaktadır. Ampirik analiz için Fourier ARDL sınır testi yaklaşımı kullanılmıştır. FARDL sonuçları, değişkenler arasında uzun dönemli bir eşbütünleşme ilişkisini ortaya koymaktadır. Bağımsız değişkenlerin CO2 emisyonları üzerindeki etkisinin analiz edilmesi amacıyla FARDL modeline dayalı uzun dönem katsayı tahmin yöntemi kullanılmıştır. Elde edilen sonuçlar, Türkiye'de ekonomik büyüme, enerji tüketimi ve kentleşmenin CO2 emisyonlarını artırarak çevre kirliliğini artırdığını göstermektedir. Genel sonuçlar, Türkiye'nin uzun vadeli sürdürülebilir kentleşme stratejileri uygulaması gerektiğini kanıtlamaktadır.

ARTICLE INFO

Article history:
Received: Nov 24, 2022
Received in revised form: March 28, 2023
Accepted: June 19, 2023

Keywords:
Urbanization
Environmental Quality
Sustainable Growth

ABSTRACT

The relationship between urbanization and the environment has recently attracted researchers' attention. In many countries, additional energy consumption caused by urbanization increases CO2 emissions and leads to environmental pollution. This study aims to test the impact of urbanization on environmental quality in Turkey, covering the period 1970-2020. The study employs the Fourier ARDL bounds testing approach for the empirical analysis. According to the findings, FARDL results reveal a long-term cointegration relationship between the variables. The FARDL-based long-term coefficient estimation model is applied to examine the effect of independent variables on CO2 emissions in the long run. Estimation results show that economic growth, energy consumption and urbanization increase environmental pollution by increasing CO2 emissions in Turkey. Overall results prove that Turkey should implement long-term sustainable urbanization strategies.

1. Introduction

The industrial revolution accelerated economic growth, causing environmental problems such as global warming and climate change. As production increases, the energy demand, the most significant input of the production process, also increases. Since energy consumption is mainly based on fossil fuels, it increases environmental pollution. According to International Energy Agency (2021), 76.2% of the world's energy consumption is still provided by fossil

* This study is the revised version of the paper which was presented at "7th International New York Conference on Evolving Trends in Interdisciplinary Research & Practices, October 1-3, 2022 / Manhattan, New York City.

** *Sorumlu yazar/Corresponding author*.
e-posta: *ademalver@gmail.com*

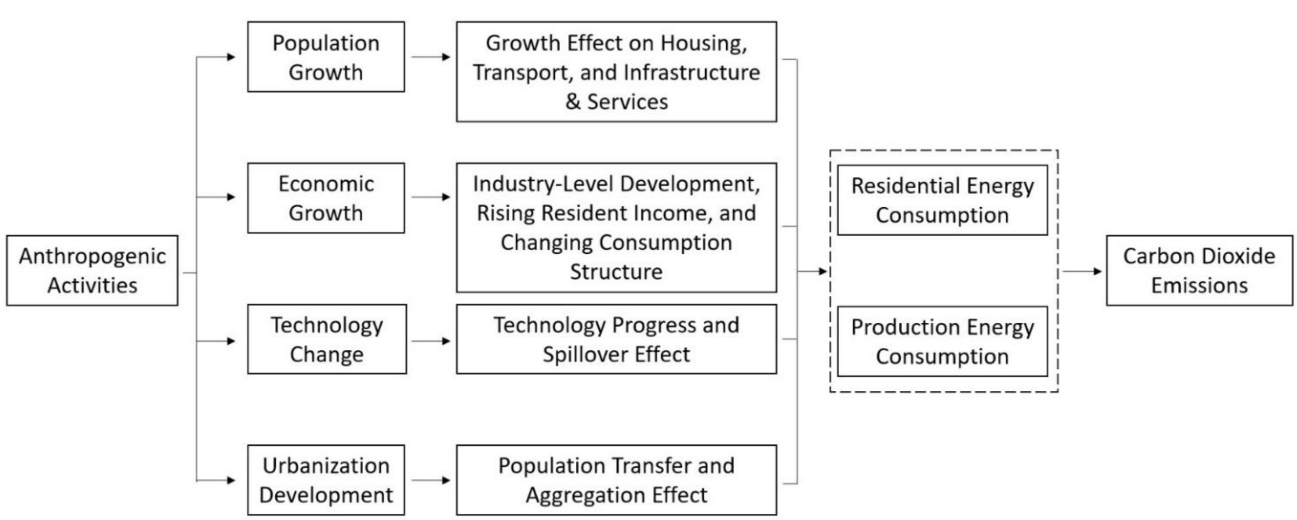
Atıf/Cite as: Sofuoğlu, E., Alver, A. & Bozali, N. (2023). An Empirical Study on the Impact of Urbanization on Environmental Quality in Turkey. *Journal of Emerging Economies and Policy*, 8(1), 204-212.

fuels (48.5% oil, 14.1% natural gas, and 13.6% coal) in 2021. Therefore, greenhouse gases have begun accumulating in the atmosphere due to the burning of fossil fuels. Environmental problems have become apparent, especially since the 1980s. After the 1990s, global warming and climate change issues have begun to resonate with a broader audience. Based on greenhouse gas emissions, mainly CO_2 emissions, climate change significantly affects all lives on the earth. To prevent environmental degradation, it is essential to mitigate CO_2 emissions (Alper & Alper, 2017; Kılıç et al., 2020), transition to a low-carbon economy, and establish climate-resilient cities.

Urbanization is a worldwide phenomenon, and the majority of the population lives in urban areas. The urbanization trend is constantly increasing in developing and developed countries (Sadorsky, 2014). While the world's urban population was 34% in 1960, this rate increased to 39% in 1980, 47% in 2000, and 56% in 2020 (World Bank, 2021). Shahbaz et al. (2016) defined urbanization as gathering residents in medium and small areas in crowded metropolises. Shahbaz (2016), who interprets this expression as the settlement of people from agricultural to non-agricultural sites, stated that economic reasons are one of the most important effects of the urbanization process. Although the economy generally induces urbanization, the impacts emerge in many areas, such as education, health, industrialization, transportation, and the environment. Figure 1 clarifies the nexus between anthropogenic activities and environmental pollution.

According to Ali et al. (2019), individuals migrate to cities mainly for three motivations: i) the predicted wage rate in cities is greater than the rural wage rate, ii) better health care, and iii) a better education system. However, resources are limited in terms of population, and many problems arise due to the increase in urban population. Most industries are located near urban areas, using fossil fuels such as coal and oil, which are generally harmful to the environment. If this risk is not managed correctly, environmental degradation will increase. Şahin and Gökdemir (2019) explained the relationship between urbanization and the environment theoretically. Accordingly, urbanization firstly stimulates population and non-agricultural activities. Then, the demand for urban areas increases due to the growing population and energy consumption after the increase in urban areas, land cover, vegetation, and city morphology change in these regions. Finally, the increase in emissions in urban areas and the change in the surface of urban land bring environmental issues such as air pollution, water pollution, and deforestation (Altıntaş, 2020). However, population growth leads to environmental pollution and increases migration from rural to urban areas (Martínez-Zarzoso & Maruotti, 2011). Poumanyvong and Kaneko (2010) explained the effect of urbanization on environmental pollution. First, they stated that energy consumption is directly associated with income level, and the urban population in low-income countries may not be as high as in middle and high-income countries. Secondly, they argued that more urban services could be provided in high-income countries, which might cause additional energy demands and environmental degradation.

Figure 1. Factors Affecting CO_2 Emission



Source: (Niu&Lekse, 2018).

As seen in Figure 1, the factors causing the increase in CO_2 emissions are; population growth, economic growth, technological change, and urbanization. Accordingly, cumulative impacts of transportation, infrastructure services, change in consumption structure, technological development, and migration stimulate CO_2 emissions.

Urbanization, which triggers CO_2 emissions, is one of the critical factors affecting climate change and environmental degradation.

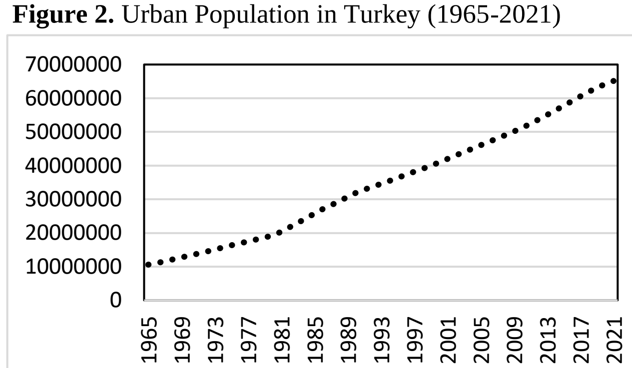
The motivation of this study is to observe how urbanization affects environmental quality in Turkey since there has been a high rate of urbanization since the 1980s. There are many studies in the literature investigating the effect of urbanization on environmental quality (Chen et al., 2022; Zhang et al., 2021; Kılıç et al., 2020; Mahmood et al., 2020; Yurtkuran, 2020; Anwar et al., 2020; Ren et al., 2015). To the best of the authors' knowledge, this is the first study to examine the urbanization-environmental quality relationship with the Fourier ARDL model for Turkey. The Fourier ARDL method allows smooth shifts and considers structural breaks thanks to the trigonometric terms included in the model. In this way, there is no requirement to apply an additional structural break test. This study examines the effect of urbanization on environmental sustainability in Turkey from 1970 to 2020. For this purpose, the Fourier ARDL method is employed for the empirical analysis. The first part gives theoretical information about urbanization and environmental linkage. Section 2 furnishes a literature summary. Section 3 introduces the methodology and reports empirical findings. Finally, we discuss empirical findings and suggest specific policy recommendations for Turkey in the conclusion.

Urbanization in Turkey

The phenomenon of urbanization in Turkey is attributed to two different periods. The first period dates back to 1950. In this period, there was weak industrialization, and the rate of urbanization was relatively low. The low rate of urbanization is also reflected in the urban population rate. This rate, which was 23.5% in 1935, could only rise to 25% in 1950. Although immigration to Ankara, İstanbul, and İzmir provinces increased before 1950, this situation was not generally reflected in the country. Ankara, one of these leading cities, became the province with the highest population growth rate due to its election as the capital city in 1923. In other cities, a similar increase was experienced with the country's population growth between 1923 and 1950, and it was observed that the effect of the internal dynamics of the cities was high. In the period after 1950, industrialization accelerated with migration and mechanization, and consequently, the rate of urbanization increased rapidly (Yılmaz & Çitçi, 2011; Işık, 2005). In the 1950s, with the effect of World War II, the concepts of human rights, freedom, and democracy came to the fore in Turkey and brought essential changes politically. However, with the transition to multi-party democracy, liberal policies have started to be implemented rather than statist policies (Niray, 2002). In this period, cities grew by exceeding the municipal boundaries of industrialization, which increased both the number and diversity of vehicles and led to the development of transportation (Osmay, 1998 cited; Niray, 2002). While the increase in the rate of urbanization in1950s was primarily due to the migration from villages to cities, it has occurred from small provinces to metropolitan towns since the 1980s (Sağlam, 2006).

After the 1980s, the free market worldwide made class differences in cities more evident and affected the adaptation of individuals to urban life negatively. There were three compelling developments in this period in Turkey. The first is the establishment of the Housing Development Administration of Turkey, the second is the abolition of The Ministry of Development and Housing, and finally, increasing the resources of the municipalities, reducing the supervision, and transferring the zoning plan approval to the authority of the municipalities (Tekeli, 1998; Yılmaz & Çitçi, 2011). While central policies were influential in shaping cities in the previous periods, urban life was influential in determining policies in this period (Yılmaz and Çitçi, 2011). While the economy was the most critical reason for urbanization before the 1990s, in the 1990s, there were more migrations due to terrorism. For this reason, individuals who had to leave their villages migrated to the Mediterranean, Aegean, Eastern, and Southeastern provinces. As a result of the migrations, there has been an increase in the urban rate in these regions (Sağlam, 2006).

Figure 2. Urban Population in Turkey (1965-2021)



Source: World Bank (2022).

As seen in Figure 2, the urban population of Turkey has been increasing regularly since 1965. The urban population was approximately 10.6 million in 1965, raised about six times, and reached 65 million by 2021. Because there are more job opportunities and better socio-economic conditions in the cities (Uysal & Taş, 2016). Considering the economic and urban population growth, it is seen that there is a need for long-term strategies in the urban population and environmental policies in Turkey.

2. Literature

In the literature, the urbanization effect on carbon emissions is explained by different theories (transition theory to urban environment, ecological modernization theory, and compact city theory). The transition theory refers to the increase in the diversity of production, which increases the economic activity in the cities and boosts industrial pollution that negatively affects air, water, and soil. The Ecological modernization theory considers urbanization as an indicator of modernization in social transformation. According to the compact city theory, which aims to benefit from economies of scale, urbanization will create economies of scale in public infrastructure and lower environmental degradation (Poumanyvong & Kaneko, 2010). These theories generally confirm that urbanization increases carbon emissions directly and indirectly.

Urbanization has gradually increased its destructive effect on the environment by expanding energy use. Many of the studies in the literature (Chen et al. (2022), Zhang et al. (2021), Anwar et al. (2020), Ren et al. (2015), Ali et al. (2019) Al-Mulali et al. (2013), Şit et al. (2021), Kılıç et al. (2020), Mahmood et al. (2020), Yurtkuran (2020), Yıldız (2019), Lee (2019), Şahin and Gökdemir (2019), Pata (2018), Niu and Lease (2017), Şimşek and Yiğit (2017), Kang et al. (2016), Shahbaz et al. (2014), Kasman and Duman (2015) and Khoshnevis and Dariani (2019)) concluded that urbanization increases environmental pollution. Contrary to these studies, there are also studies detecting a negative relationship between urbanization and carbon emissions (Fan et al., 2006; Liddle & Lung, 2010; Hossain, 2011; Sharma, 2011; Lv & Xu, 2018; Ahmed et al., 2019; Altıntaş, 2020; Jozwik et al., 2022; Saidi & Mbrak, 2016). Poumanyvong and Kaneko (2010) stated the importance of planned urbanization and claimed that developed countries have more opportunities than others. Agricultural lands and renewable resources also highlight the importance of natural resources. Table 1 presents the literature summary.

Table 1. Literature Review

Authors	Period	Countries	Method	Results
Chen et al. (2022)	1996-2018	OECD	Generalized Least Squares	An inverted U-shaped relationship was captured between urbanization and environmental degradation.
Jozwik et al. (2022)	2000-2018	EU Countries	FMOLS	Urbanization mitigates CO_2 emissions.
Zhang et al. (2021)	2000-2012	China	GMM	Population migration and CO_2 emissions are directly related.
Anwar et al. (2020)	1980-2017	Far East Countries	Fixed Effect Model	Urbanization increases CO_2 emissions in analyzed countries.
Ahmed et al. (2019)	1971-2014	Indonesia	STRIPAT Model	While urbanization initially triggers environmental degradation, the impacts turn positive after reaching higher economic growth.
Ali et al. (2019)	1972-2004	Pakistan	ARDL	Urbanization increases carbon emissions.
Khoshnevis and Dariani (2019)	1980-2014	Asian Countries	Pooled Mean Group	Urbanization triggers energy consumption and CO_2 emissions.
Yıldız (2019)	1992-2014	E7 Countries	Causality Test	One-way causality from urbanization to CO_2 emissions was detected.
Şahin and Gökdemir (2019)	1995-2016	Turkey	Root Mean Square Error Method	Urban population growth is the most critical determinant of greenhouse gas emissions.
Pata (2018)	1974-2013	Turkey	ARDL Cointegration Test	Energy consumption increases CO_2 emissions.
Lv and Xu (2018)	1992-2012	55 Middle-Income Countries	Pooled Mean Group Estimation	Urbanization impacts environmental pollution negatively.
Niu and Lekse (2017)	2002-2013	China	Dynamic Spatial Durbin Panel Model	Short and long-term relationships were captured between urbanization and environmental pollution.
Şimşek and Yiğit (2017)	1990-2015	BRICT Countries	Dumitrescu Hurlin Panel Causality Analysis	A unidirectional causality has been identified from economic growth to urbanization.
Saidi and Mbrak (2017)	1990-2003	19 Developing Countries	Generalized Momentum System Model	Urbanization reduces CO_2 emissions.
Kang et al. (2016)	1997-2012	Provinces of China	Spatial Panel Data Approach	Urbanization and coal burning are the main factors in the increase of CO_2 emissions.
Ren et al. (2015)	2015-2020	China	CECM	Urbanization affects CO_2 emissions and energy consumption positively.
Asif et al. (2015)	1980-2010	Gulf Countries	FMOLS Cointegration Test	Urbanization affects CO_2 and energy consumption positively.
Shahbaz et al. (2014)	1975-2011	UAE	ARDL Cointegration	The rise in urbanization increases CO_2 emissions.
Kasman and	1992-2010	15 Countries	Granger	Results reveal a unilateral causality from urbanization and

Duman (2015)			Causality	energy consumption to CO_2 emissions.
Sadorsky (2014)	1971-2009	Developing Countries	STIRPAT Model	Results reveal an insignificant relation between urbanization and CO_2 emissions.
Al-Mulali et al. (2013)	1980-2009	MENA	Dynamic OLS	Urbanization triggers CO_2 emissions.
Zhu et al. (2012)	1992-2008	20 Developing Countries	Panel Data Analysis	Contrary to previous studies, there is a weak and relation between CO_2 and urbanization.
Hossain (2011)	1971-2007	Newly Industrialized Countries	Panel Granger Causality	Urbanization has a negative impact on environmental degradation.
Martínez-Zarzoso and Maruotti (2011)	1975-2003	Developing Countries	STIRPAT Model	The impacts of urbanization on environmental quality vary based on income groups.
Sharma (2011)	1985-2005	69 Countries	Dynamic Panel Data	Urbanization lowers CO_2 emissions.

3. Model and Data

This study shows the nexus among CO_2 emissions, economic growth, urban population, and primary energy consumption from 1970 to 2020 for Turkey in the model below. All series are logged to avoid scale issues.

$$LNCO_{2it} = \beta_0 + \beta_1 LNGDP_{it} + \beta_2 LNURB + \beta_3 LNEN_{it} + \varepsilon_{it} \quad (1)$$

CO_2 represents carbon dioxide emissions, GDP represents economic growth, URB represents the urban population, and EN represents energy consumption. CO_2 emissions and primary energy consumption data were obtained from the Our World in Data database. Urban population and GDP data were obtained from the World Bank.

The ARDL approach takes into account the F and t statistics. If the test statistic exceeds the critical upper bound values, there is no cointegration, and the primary hypothesis is rejected. Equation (2) shows the ARDL model created for empirical analysis.

$$\Delta LNCO_{2t} = \beta_0 + \beta_1 LNCO_{2t-1} + \beta_2 LNGDP_{t-1} + \beta_3 LNURB_{t-1} + \beta_4 LNEN_{t-1} + \sum_{j=1}^{\rho-1} \varphi_i' \Delta LNCO_{2t-i} + \sum_{i=1}^{\rho-1} \delta_i' \Delta LNGDP_{t-i} + \sum_{i=1}^{\rho-1} \emptyset_i' \Delta LNURB_{t-i} + \sum_{i=1}^{\rho-1} \vartheta_i' \Delta LNEN_{t-i} + e_t \quad (2)$$

Δ represents the first difference operator, and ρ represents the lag length. Pesaran et al. (2001) use F-test (F_A) and t-test (t) to determine a cointegration relationship.

$$H_{0A}: \beta_1 = \beta_2 = \beta_3 = 0 \quad (3)$$

$$H_{0B}: \beta_1 = 0 \quad (4)$$

McNown et al. (2018) developed an additional F-test (F_B), which tests the main hypothesis.

$$H_{0C}: \beta_2 = \beta_3 = 0 \quad (5)$$

To accept the cointegration, Equations (3), (4), and (5) must be rejected. The Fourier ARDL method produces more reliable findings since it considers structural breaks without adding dummies to the model. Equations (6) and (7) show Fourier functions and Equation (8) indicates the Fourier model for the paper.

$$d(t) = \sum_{k=1}^{n} a_k \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} b_k \cos\left(\frac{2\pi kt}{T}\right) \quad (6)$$

While n is the number of frequencies, k is the number of specific frequencies selected, t is the trend, and T is the sample size. The frequency value suggested by Ludlow and Enders (2000) and Becker et al. (2006) was used in the equation.

$$d(t) = \gamma_1 sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 cos\left(\frac{2\pi kt}{T}\right) \quad (7)$$

$$\Delta LNCO_{2t} = \beta_0 + \gamma_1 sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 cos\left(\frac{2\pi kt}{T}\right) + \beta_1 LNCO_{2t-1} + \beta_2 LNGDP_{t-1} + \beta_3 LNURB_{t-1} + \beta_4 LNEN_{t-1} + \sum_{i-1}^{\rho-1} \varphi_i' \Delta LNCO_{2t-i} + \sum_{i-1}^{\rho-1} \delta_i' \Delta LNGDP_{t-i} + \sum_{i-1}^{\rho-1} \emptyset_i' \Delta LNURB_{t-i} + \sum_{i-1}^{\rho-1} \vartheta_i' \Delta LNEN_{t-i} + e_t \quad (8)$$

4. Empirical Results

For Fourier ARDL cointegration analysis, unit root tests should be carried out first. In the FARDL method, the dependent variable must be integrated at the first difference, while independent variables should be stationary both at the level and first difference. For this reason, ADF and Fourier ADF unit root tests are used in this study. First, the Fourier ADF unit root test was applied for empirical analysis. According to the Fourier ADF unit root test results, the trigonometric terms of the $LNCO_2$, LNGDP, and LNURB are insignificant. In this case, Enders and Lee (2012) offer employing the traditional ADF unit root test. Table 1 shows descriptive statistics and Table 2 shows both Fourier ADF and conventional ADF unit root test results.

Table 1: Descriptive Statistics

	$LNCO_2$	LNGDP	LNURB	LNEN
Mean	18.923	26.568	1.073	6.450
Median	19.017	26.547	0.968	6.566
Maximum	19.880	26.547	0.968	7.514
Minimum	17.567	25.480	0.341	4.988
Std. Dev.	0.676	0.636	0.366	0.723
Skewness	-0.292	0.094	0.335	-0.276
Kurtosis	1.861	1.889	2.474	1.961
Jarque-Bera	3.480	2.697	1.541	2.945
Probability	0.176	0.260	0.463	0.229
Observations	51	51	51	51

Table 2. Fourier ADF (FADF) Unit Root Test

Variables	Frequency	FADF Test Values	F Test	ADF Test (level)	ADF Test (Δ, first difference)
$LNCO_2$	5	-2.41	6.02	-2.55	-6.09*
LNGDP	5	0.02	2.94	-0.28	-6.72*
LNURB	2	-1.32	1.26	-1.19	-4.45*
LNEN	5	9.58**	-2.59	-2.53	-6.82*

Note: *, **, and *** are FADF critical values for %1, %5, and %10, respectively, and the values are: 12.21, 9.14, and 7.78, respectively.

According to the ADF unit root test results, all variables ($LNCO_2$, LNGDP, LNEN and LNURB) are not stationary at their level values but are stationary at their first differences. The condition for ARDL bounds test is that the dependent variable must be stationary at the first difference I(1). Therefore, the obtained unit root test results allow cointegration estimation. The FARDL bounds test method is used to test the cointegration relationship between the series.

Table 3. FARDL Test Results

		Bootstrap Critical Values		
Optimal Frequency	F_A	10%	5%	1%
1	4.86[a]	2.65	3.18	4.32
	t	10%	5%	1%
	-2.31[b]	-1.54	-2.03	-2.59
	F_B	10%	5%	1%
	5.11[a]	2.72	3.46	4.6

Note: [a and b] show statistical significance at %1, and %5 significance levels, respectively.

Table 3 shows F_A, t, and F_B test statistics and Bootstrap critical values. According to this, F_A and F_B statistics are statistically significant at the 1% significance level and t statistics is statistically significant 5% significance level. These findings show a long-term cointegration between CO_2 emissions, urbanization, economic growth, and energy consumption during the 1970-2020 period in Turkey. The long-term coefficient estimation is applied after determining the long-term relationship between the variables. Table 4 shows the selected ARDL model for the study and Table 5 presents long-term coefficient results.

Table 4: FARDL model for the empirical model (1,0,1,0)

Variables	Coeff.	Std. Err.	t-Stat.	Prob.
$LNCO_2(-1)$	0.179	0.105	1.705	0.096
LNGDP	0.277	0.155	1.789	0.081
LNURB	-0.039	0.042	-0.935	0.355
LNURB(-1)	0.092	0.042	2.178	0.035
LNEN	0.569	0.151	3.778	0.001
@SIN(2*@ACOS(-1)*1*@TREND/51)	-0.063	0.011	-5.508	0.000
@COS(2*@ACOS(-1)*1*@TREND/51)	-0.036	0.016	-2.245	0.030
C	4.551	3.959	1.149	0.257
@TREND	-0.004	0.004	-0.927	0.359

Note: Fourier trigonometric terms are added to the empirical model. For this model, the optimum lag length is 1 based on the Akaike information criteria.

Table 5. Long-Term Coefficient Estimation

LNURB	LNGDP	LNEN
0.06[b]	0.34[c]	0.69[a]
(0.04)	(0.10)	(0.00)

Note: $LNCO_2$ is the dependent variable. Fourier functions were added to the model. Numbers in parentheses indicate p-values. [a], [b], and [c] show significance at the 1%, 5%, and 10% levels, respectively.

According to Table 5, all independent variables (LNURB, LNGDP and LNURB) are statistically significant and positive. These findings show that economic growth, energy consumption and urbanization lower environmental quality by increasing CO_2 emissions. In other words, a 1% increase in economic growth, energy consumption and urbanization lead to a rise in CO_2 emissions by 0.34%, 0.68% and 0.06%, respectively. These results are similar to the studies conducted by (Niu & Lekse, 2017; Pata, 2018; Khoshnevis & Dariani, 2019; Al-Mulali et al., 2013). It is generally accepted that both urbanization and economic growth have negative impacts on environmental quality due to increasing CO_2 emissions. Economic growth stimulates industry and consumption. This situation also leads to higher CO_2 emissions due to burning fossil fuels. Yıldız (2019), Şimşek and Yiğit (2017), and Kasman and Duman (2015) found causality from CO_2 emissions to economic growth and urbanization.

Table 6: Error Correction Model Estimation (1,0,1,0)

Variables	Coeff.	Std. Err.	t-Stat.	Prob.
C	4.546822	0.414685	10.96453	0.0000
D(LNURB)	-0.039112	0.034863	-1.121880	0.2684
@SIN(2*@ACOS(-1)*1*@TREND/51)	-0.062851	0.008769	-7.167307	0.0000
@COS(2*@ACOS(-1)*1*@TREND/51)	-0.035995	0.006414	-5.612350	0.0000
CointEq(-1)*	-0.820881	0.075604	-10.85765	0.0000

According to the short-run coefficient estimation, the error correction model is negative and statistically significant (CointEq(1)), which means that 82% of the deviations that occur in the short term are balanced in the long-term.

5. Results and Policy Recommendations

This paper investigates the nexus between urbanization and environmental sustainability in Turkey during 1970-2020. To this end, FARDL cointegration and long-term coefficient estimators based on FARDL were used, and economic growth and energy consumption variables were added to the model as control variables. Empirical findings revealed a long-term cointegration relationship between variables. In addition, it was determined that economic growth, energy consumption and urbanization increase environmental pollution by increasing CO_2 emissions in the long run. These findings show similarity with the previous studies conducted by (Kılıç et al., 2020; Mahmood et al., 2020; Yurtkan, 2020; Lee, 2019; Ali et al., 2019; Şahin & Gökdemir, 2019; Pata, 2018; Niu & Lekse, 2017; Kang et al., 2016; Asif et al., 2015). On the other hand, Zhu et al. (2012) disagree with the result determining a weak inverted U-shaped relationship between urbanization and environmental pollution. Sadorsky (2014), on the other hand, claims that urban population growth has an insignificant relationship with CO_2 emissions. Rapid and unplanned urbanization, high population density, air pollution, and low amount of green space per capita make protecting environmental quality and sociodemographic characteristics challenging. As Şahin and Gökdemir (2019) stated, urgent strategies are required to mitigate the adverse effects of urbanization on the environment in Turkey. These strategies are as follows: i) Turkey should implement long-term policies regarding agricultural reform to reverse rural-urban migration. ii) Cities should be divided into eco-communities and designed by the transportation capacity. iii) Occupational diversity should be ensured by integrating the industrial and agricultural sectors. iv) Public awareness of the environment should be increased through environmental education and media. Taş and Doğan (2016) found that urbanization increases economic growth in Turkey. They suggest that the city population should be informed about environmental issues. Furthermore, governments should promote the use of environmentally friendly products. In addition, they also recommend that urban expansion should be systematical, considering environmental protection and planning. Finally, opportunity inequalities between rural and urban areas should be reduced. This way, environmental degradation might reduce due to decreasing migration from rural to urban areas.

The adverse effect of income and urbanization on environmental sustainability indicates that Turkey needs to combine long-term environmental and urbanization policies. Therefore, policymakers should focus on the transition to the low-carbon economy model. As it is known, Turkey's most significant commercial partner is the European Union. For this reason, the recent commercial regulations in the field of environment in the European Union should be followed carefully. For example, the carbon border adjustment is mentioned within the scope of the European Green Agreement prepared by the European Union. This practice will affect the international competitiveness of the European Union and its commercial partners. The purpose of this application is to reflect the environmental costs incurred by European companies to other country companies. This way, the European Union tries to limit the carbon intensities of imported products by applying customs duties/carbon tax on carbon-intense imports and tries to prevent carbon leakage. This practice aims to achieve a competitive advantage and protect the competitiveness of European companies by ensuring that other countries endure the environmental standards and regulations like EU companies. At this point, some risks and opportunities emerge for Turkey. Accordingly, Turkey needs to make the necessary arrangements to transition to a greener economy model in the long term to avoid a potential risk of market loss. If Turkey meets the requirements, it can increase its market share due to losses arising from other countries. Therefore, Turkey's transition to a green economy in the long term is thought to be an opportunity, not a threat to the economy.

The limitation of this study is not to consider subcomponents of urbanization. For this reason, the future direction of this study is to investigate how the subcomponents of urbanization affect the economy and environment in the short and long term. In this way, researchers will be able to observe the interaction between urbanization and the environment in detail and suggest more specific policy recommendations.

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