

Financial sector development, energy consumption, and CO₂ emission in Turkey. Fresh evidence from a new combined co-integration and Bootstrap ARDL tests

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ABSTRACT

The major purpose of this paper is to investigate the influence of financial sector development, renewable and non-renewable energy consumption on CO₂ emissions in Turkey. Autoregressive Distributed Lag testing model (ARDL), the Dynamic Ordinary Least Squares (D-OLS), Fully Modified Ordinary Least Square (FM-OLS), Canonical Cointegrating Regression (CCR) approaches are utilized to test a long-run interaction among the examined variables. To provide new empirical evidence, the study utilizes the newly developed bootstrap (ARDL) testing approach as proposed by (McNown et al. 2018), and the newly developed combined co-integration of Bayer and Hanck as proposed by Bayer and Hanck (2013). The long-run coefficients of ARDL, D-OLS, FM-OLS, and CCR show that the ECK model is valid in Turkey. Besides, the findings show that financial sector development has a powerful influence on CO₂ emission in Turkey. Furthermore, the findings demonstrate that non-renewable energy increases CO₂ emission. In contrast, renewable energy can decrease CO₂ emissions. The findings of this research provide valuable conclusions and recommendations for Turkey heading to sustainable and green economic growth. It is suggested that the government policymakers in Turkey are required to make more investment in renewable technologies to decrease CO₂ emission.

Keywords: Turkey, Financial sector development, CO₂ emissions, Bayer and Hanck, Bootstrap ARDL.

Mathematics Subject Classification: 37N40, 74G65, 97M40

(JEL) Classification Number: D, E, O, R

1. INTRODUCTION

The financial sector in Turkey experienced a positive development from 2001 to 2015; for example, it experienced rapid growth in total assets during over this period, the credits provided by the financial institutions and banks to the private-sectors increased from 11.79% of GDP in 2001 to 50% in 2014, thus the energy consumption of Turkey is perpetually increasing, which in turn may lead to increase the environment population. Hence, it's highly important to test the interaction among the financial development and the environmental degradation. However, the development of the financial sector has a powerful effect on economic efficiency such as reduce the cost of borrowing, financial and business risk, access to greater capital, as well as can affect energy demand, and consumption through using the newest energy-efficient products and techniques (Sadorsky, 2011). Hence, the financial development may increase the capital accumulation efficiency and investment. Therefore, development of the financial sector can affect positively economic growth rates. In this sense, the financial

development enhances financial innovation and promoting the adoption of advanced technology (McKinnon, 1973).

However, the financial development can affect the demand and consumption of energy in several ways such as the improved financial system enables consumers to borrow for their personal needs. This impact is called a direct impact (Samour et al., 2019). Besides, the development of the financial sector may affect energy consumption, when it enables businesses to access capital cheaply and easily. This is an influence called a business impact (Sadorsky, 2011).

Shahbaz et al., (2015) stated that financial sector development offers cheaper loans to the producer, then they purchase advance raises consumption of energy. However, the financial sector development may affect energy consumption through other economic channels such as economic growth and investments. For instance, financial sector development 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 can lead to an increase the consumption of energy and CO₂ emission. However, This research focuses on the influence of financial sector development, non renewable-energy consumption, renewable energy consumption, and GDP on Turkey's carbon emissions from 1985-2015. However, Turkey has faced several changes in the economic structure over the period 1985 to 2015, the economic performance showed that GDP in Turkey has increased to around 210% from 1985 to 2015. On the other hand, Turkey has limited crude oil reserve. In this sense, Turkey's oil production was reported at 314,000 Barrel/Day in 1980 and reached to 731,000 Barrel/Day in 2014. Figure1 shows the consumption and production of oil over the tested period from 1980 to 2014. Turkey's demand for crude oil from global markets has increased constantly in the last 30 years. In 2015 Turkey's total liquid fuel consumption averaged about 861,000 Barrel/Day and more than 90% of total crude oil came from imports (Turkstat, 2020). Although Turkey has limited crude oil reserves, nonrenewable energy consumption (kg of oil equivalent) has increased around 220% over the period from 1985 to 2015. Energy consumption was 715,149 kg of oil equivalent in 1980 and reached 1,577,828 kg of oil equivalent in 2014. In this line, increasing urbanization, demographic trends, and increasing per capita economic growth are boosting the consumption of energy in Turkey (Samour et al., 2020).

Nonrenewable energy resources are delectable and negatively affect the environment. At the same time, it will increase the dependence abroad for energy. Due to these reasons, the importance of renewable energy has risen in Turkey. However, Turkey needs to lead in renewable energy resources. Thus, the sustainable economic development of Turkey will increase and environmental pollution will be lower within this process, and a contribution that was made to renewable energy resources of Turkey will inevitably rise in overall energy consumption (Erdogan et al., 2020).

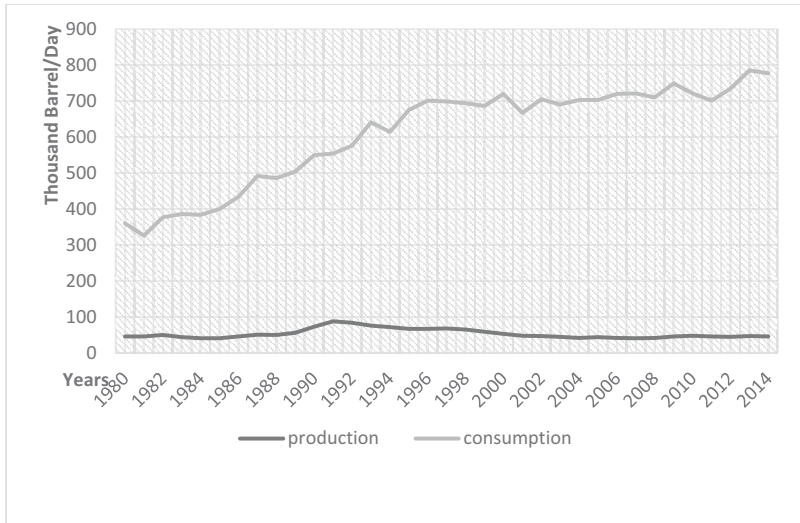


Figure 1 Consumption and production of oil in Turkey for selected period 1980-2014.

However, this article aims to explore the interaction among the financial sector development index and CO₂ emission in Turkey. Furthermore, this paper aims to explore the interaction among energy consumption and (GDP) and carbon dioxide (CO₂) emissions in Turkey for the period 1992–2015. The research uses the following unit root tests: Zivot-Andrews, the Perron-Vogelsang, with one structural break dates SBD. To provide new empirical evidence to the literature, the study uses the (ARDL) bootstrap testing approach as suggested by (McNown et al. 2018). Furthermore, a new technique combined with co-integration tests (Bayer and Hanck, 2013) is employed to affirm the outcomes of the ARDL test. The (ARDL) model is applied for long-run estimates and the D-OLS, FM-OLS, and CCR testing approaches are utilized to examine the estimation coefficients amongst the tested variables in the long run.

2. REVIEW OF LITERATURE

Several studies demonstrate the financial sector development has a powerful influence on carbon emissions. Zhang (2011) examined the effect of financial sector development on the consumption of energy and carbon emission in China from 1980 to 2009. The results found that financial sector affect positively non-renewable energy consumption and carbon emission in China. Al-Mulali and Lee (2013) explored the influence of financial sector development on the carbon emissions in MENA countries over the selected period 1980 to 2009. By applying DOLS, the results showed that financial sector development affects positively CO₂ emission in MENA countries. Shahbaz et al. (2015) employed the VECM testing model and supported that financial sector development affects positively CO₂ emission in India during the period from 1970-2012. Pata (2018) applied the ARDL testing approach and examined the influence of financial sector development on CO₂ emission in Turkey. Using the ARDL model. The results implied that financial sector development has a significant driver for the increase in the consumption of energy and environmental degradation in Turkey. Haseeb et al. (2018) showed that

there a positive linkage amongst the financial sector development and CO₂ emission in Russia India, China, and South Africa during the period 1995 to 2014.

However, these studies suggested that financial development has a powerful influence on economic activities, which in turn led to an increase in the consumption of energy and the environmental population. In contrast, Tamazian et al. (2009) tested the effect of financial development CO₂ emission in Russia India, South Africa, and China from 1992 to 2004. The findings implied that the financial-development led to a reduce nonrenewable energy consumption and carbon emissions in South Africa, Russia, India, and China.

On the other hand, several papers tested the interactions between consumption of renewable energy and nonrenewable energy, economic growth(GDP), and CO₂ emission. In this regard, Samour et al., (2019) employed the ARDL model, and suggested that nonrenewable energy consumption has an inverse relation with carbon emission. Furthermore, the findings showed the EKC is valid in Turkey for the tested period 1980-2014.

Tien Pao et al. (2011) indicated that there is a bi-directional causal linkage amongst CO₂ emission and energy consumption in Russia. Bouk and Mert (2015) examined the linkage amongst economic growth and energy consumption and Turkey's CO₂ emissions by applying the ARDL approach. The outcomes have shown that the consumption of renewable energy and economic growth negatively affects CO₂ emissions. Magazzino (2016) tested the linkage among energy consumption, GDP, and carbon emissions in Turkey from 1992 to 2013 by using the panel VAR model. The results suggest energy consumption affect negatively carbon emissions.

Bento and Moutinho (2016) tested the influence of energy consumption (non-renewable and renewable) and economic growth on CO₂ emissions in Italy over the tested period from 1960-2011, by using the ARDL approach The outcomes found that renewable energy and GDP are negatively affected by carbon emissions. In contrast, the results found that non-renewable energy is significant and positively affects CO₂ emissions. Bilgili et al. (2016) analyzed the influence of renewable energy and economic growth on CO₂ emissions in 17 selected countries for the period from 1980 to 2011, by using Panel FM-OLS and D-OLS tests. The outcomes found the EKC hypothesis is valid in selected countries. Shafiei and Salim (2014) found an inverse linkage amongst CO₂ emissions and renewable energy consumption, and an inverse interaction among consumption of energy and CO₂ emissions in selected OECD-countries. Chen and Geng (2016) tested the influence of renewable energy consumption and carbon emissions in 30 OECD countries by using Panel data for the period from 1980-2011. The outcomes showed that there is a negative linkage between renewable energy and carbon emission. Doğan and Öztürk (2017) tested the influence of energy consumption and economic growth on carbon-emissions in the USA over the tested period from 1960 to 2010. The findings confirmed that non-renewable energy consumption and GDP affect positively CO₂ emissions. In contrast, renewable-energy consumption affect negatively CO₂ emissions.

3. RESEARCH MODEL AND DATA

In the classical EKC model, (GDP), (GDP²) variables are the major determinants of CO₂ emissions. The reason of why the conventionally (GDP²) is applied that economies might have an inverted *U – shaped* EKC. However, the study uses the following factors: financial sector development, non-renewable and renewable energy consumption, which are other main determinants of CO₂ emissions. Thus, the next is the EKC model:

$$CO_2 = f(GDP, GDP^2, FSD, REC, NREC) \quad (1)$$

where CO₂ represents the carbon dioxide emissions, (GDP, and GDP²) are the economic growth, GDP², NREC is the consumption of non-renewable energy, and REC represents consumption of renewable energy. However, the main assumption of this research is: the following factors: (FSD), (REC) (NREC), (GDP), and (GDP²) affect CO₂ emissions. Thus, the next equation can be checked:

$$\ln CO_{-2t} = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \ln GDP_t^2 + \beta_3 \ln FSD_t + \beta_4 \ln REC_t + \beta_5 \ln NREC_t + \varepsilon_{it} \quad (2)$$

where $\ln CO_{-2}$ is the log of the carbon-emissions, $\ln GDP$ is the economic growth in constant 2010 USD, $\ln GDP^2$ is the quadratic of GDP, $\beta_3 \ln FSD_t$ is financial sector development index determined by credits which provided by the banking sector to the market as a share of economic growth in Turkey, $\ln REC$ is the logarithm of consumption of renewable energy, which is a share of total final energy consumption, $\ln NREC$ is a logarithm of non-renewable energy consumption which includes (coal, petroleum, gas). The selected data is obtained from (World-Bank). The selected data is yearly data covers the period from 1985 to 2015.

3.1 Stationary and co-integration tests

To test the cointegration amongst the selected variables, the research tested whether the tested data is integrated, and stationary. The paper applies unit root tests with SBD such as *Zivot – Andrews* (2002), *Perron – Vogelsang* (1999) tests with one structural break to affirm the unit roots tests. To verify the existence of the long-run linkage amongst tested variables. The study applies the ARDL bounds testing approach. Unlike other approaches, the model examines if there is co-integration amongst the selected variables in three cases: if all tested variables are integrated and stationary at a level $I(0)$ or at the first difference $I(1)$, or mix $I(0)$ and $I(1)$ (Pesaran et al, 2001). Additionally, the ARDL testing approach allows the tested variables to have various lags.

Recently, this approach improved by McNown et al. (2018), the last version of this test includes $t_{dependent}$ or F-test $F_{independent}$ on the coefficients of lagged independent tested variables. The H_0 of $t_{dependent}$ test is: $\sigma_1 = 0$. The H_1 of $t_{dependent}$ test is: $\sigma_1 \neq 0$. While The H_0 of $F_{independent}$ test is: $H_0: \sigma_2 = \sigma_3 = \sigma_4 = \sigma_5 = 0$. The H_1 of $F_{independent}$ test is: $H_1: \sigma_2 \neq \sigma_3 \neq \sigma_4 \neq \sigma_5 \neq 0$.

The bootstrap ARDL critical values (CV) includes the features of the combination integration of each time-series employing the ARDL bootstrap procedures. These steps will lead to overcoming the

instability issue in the findings of traditional co-integration tests, it will lead to getting better outcomes than the traditional co-integration tests (Pata. 2019). In particular, the Pesaran et al. (2001) CV allow for (one) tested variable to be endogenous, while the CV in a bootstrap test allow for the endogeneity of selected explanatory variables. Also, this technique is suitable for time-series data that includes more than (one) explanatory tested variable (Goh et al. 2017). The cointegration amongst economic growth, international trade, banking sector development, and oil consumption will be determined if the values of $F - Pesaran, t - dependent, F - independent$ higher than the CV bootstrap technique (McNown et al.,2018). The ARDL testing approach equation is as follows:

The testing model of (FSD), (NREC), (REC), GDP, GDP², and CO₂ emissions is formulated as follows:

$$\Delta \ln CO_{-2t} = \beta_0 + \sum_{i=1}^n \gamma_1 \Delta \ln CO_{-2t-j} + \sum_{i=1}^n \gamma_2 \Delta \ln GDP_{t-j} + \sum_{i=1}^n \gamma_3 \Delta \ln GDP_{t-j}^2 + \sum_{i=1}^n \gamma_4 \Delta \ln FSD_{t-j} + \sum_{i=1}^n \gamma_5 \Delta \ln REC_{t-j} + \sum_{i=1}^n \gamma_6 \Delta \ln NREC_{t-j} + \sigma_1 \ln CO_{2t-1} + \sigma_2 \ln GDP_{t-1} + \sigma_3 \ln GDP_{t-1}^2 + \sigma_4 \ln FSD_{t-1} + \sigma_5 \ln REC_{t-1} + \sigma_6 \ln NREC_{t-1} + \varepsilon_{1t} \quad (3)$$

where Δ means the first difference operator, $\ln CO_{-2}$ is the logarithm of the dependent variable, $\ln GDP$, $\ln GDP^2$, $\ln FSD$, $\ln REC$, $\ln NREC$ are the logarithm of the independent tested variables; n is the lags optimal; and ε_{1t} is the error-disturbance of the tested model. The error correction model is predestined by equation(4):

$$\Delta \ln CO_{-2t} = \beta_0 + \sum_{i=1}^n \beta_1 \Delta \ln CO_{2t-j} + \sum_{i=1}^n \beta_2 \Delta \ln GDP_{t-j} + \sum_{i=1}^n \beta_3 \Delta \ln GDP_{t-j}^2 + \sum_{i=1}^n \beta_4 \Delta \ln FSD_{t-j} + \sum_{i=1}^n \beta_5 \Delta \ln REC_{t-j} + \sum_{i=1}^n \beta_6 \Delta \ln NREC_{t-j} + ECT_{t-1} + u_t \quad (4)$$

where Δ represents a change in $\ln CO_{-2}$, $\ln GDP$, $\ln GDP^2$, $\ln FSD$, $\ln REC$, $\ln NREC$, and ECT_{t-1} is expected to be significant with a (-)sign, this sign means the velocity of adjustment in short and long relation.

Furthermore, the BH-2020 test is applied to test affirm the outcomes of the ARDL testing model. The main advantage of this test is that this test includes (4) cointegration approaches: 1.Engle and Granger(1987), 2.Johansen (1988)(JOt), 3.Boswijk(1994), 4. Banerjee et al. (1998). However, this test includes the *Fisher F*-statistics to affirm the cointegration findings. This test is formulated and presented as follows:

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

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

where $EGt - JOHt - BOt - BDMt$ are cointegration tests. By comparing the combined cointegration *Fisher F*-statistics to the critical-values, H_1 of co-integration condition in long run will not be accepted if the computed *Fisher F*.statistics values are lower than the BHT values.

Furthermore, the uses FM-OLS testing model as suggested by (Phillips and Hansen,1990), DOLS testing model as suggested by (Stock and Watson,1993), and CCR testing model as suggested by (Par,1992) to affirm the findings of this paper. In addition, the study uses the Normality, Breusch-Pagan Godfrey, LM, ARCH, and Ramsey-Reset tests in order to confirm that there is no autocorrelation, and there is normal distribution in the tested model.

4. Findings and Discussions

The (ZA) and (PV) unit root tests with one SBD are shown in Table 1 and Table 2; These tests suggest one and two structural breaks dates (SBD) in the variables. It was showed by these unit root tests that all the tested variables of this study are non-stationary and integrated at level, but they are integrated and stationary at the first difference. However, the outcomes of the ZA and PV tests show that $\ln CO_{-2}$, $\ln GDP$, $\ln GDP^2$, $\ln FSD$, $\ln REC$, $\ln NREC$ variables have $I(1)$ order of integration. Hence, Equation 1 in this study can be used as an acceptable tested model of cointegration levels.

Table 1. ZA test results

At-level			At Δ		
Variables	t-stat	SBD	Variables	t-stat	SBD
$\ln CO_{-2}$	-2.711	2001	$\Delta \ln CO_2$	-5.112**	1999
$\ln GDP(\ln GDP^2)$	-2.310	1995	$\Delta \ln GDP(\ln GDP^2)$	-6.213*	2008
$\ln FSD$	-3.223	1995	$\Delta \ln FSD$	-6.521**	2001
$\ln REC$	-2.991	1999	$\Delta \ln REC$	-7.731**	2005
$\ln NREC$	-2.331	2004	$\Delta \ln NREC$	-8.322**	1998

Note, *, ** symbolize significance of variables at 5%, 1%. Level.

Table 2 The PV test results

At level			At Δ		
Variables	t-statist	SBD	Variables	St-stat	BD
$\ln CO_{-2}$	-2.553	2001	$\Delta \ln CO_2$	-7.321**	2001
$\ln GDP(\ln GDP^2)$	-2.112	2008	$\Delta \ln GDP(\ln GDP^2)$	-6.225**	2008
$\ln FSD$	-3.331	2009	$\Delta \ln FSD$	-7.310**	1998
$\ln REC$	-2.102	1998	$\Delta \ln REC$	-6.163**	2010
$\ln NREC$	-2.31	1999	$\Delta \ln NREC$	-6.651**	1999

Note, *, ** symbolize significance of variables at 5%, 1%. Level.

The findings of the Bootstrap ARDL approach of cointegration are showed in Table 3. The Bootstrap ARDL findings confirm that there is co-integration amongst $\ln CO_{-2}$, $\ln GDP$, $\ln GDP^2$, $\ln FSD$, $\ln NREC$, and $\ln REC$.

Furthermore, the findings of the BH-2013 are showed in Table4. The findings provide strong empirical evidence that there is a cointegration amongst the tested variables, which affirm the findings of the ARDL test.

Table 3 The results of Bootstrap ARDLApproach

ARDL(1,1,1,0,1,1) (CO ₂ , GDP, GDP2, FSD, REC,NREC)		$F_{Pesaran}$	$t_{dependent}$	$F_{independent}$
		5.712***	-3.87***	6.52***
Bootstrap-based table CV	1%	3.99	-3.88	7.06
	5%	3.28	-3.08	4.85
	10%	2.94	-2.85	3.96

***, **, * symbolize statistical sign at 1%,5%,10% level respectively

Table 4 Results of BH-2013 test

Fisher.- statistics		
	EGT/JOT	EGT/JOT/BOT/BAT
	15.131**	22.310 **
Significantly level at (5%)	10.419	19.888

*,**,*** symbolize the significance of tested variables at 1%, 5%, 10% level, respectively.

The estimation coefficients, in the long-run levels from ARDL, FM-OLS, D-OLS, and CCR are presented in Table 5. The estimation coefficient of “GDP” in long run is positive (+) and statistically significant, and “GDP²” in long-run is negative (–), and statistically significant. However, the empirical findings confirm that the EKC-model is valid in Turkey. It means that as the level of economic growth increases, CO₂ emissions will increase. But after a specific period, it will lead to a reduction in CO₂ emissions. These findings are in line with Samour et al. (2020).

On other hand, the outcomes show that the coefficient of non-renewable energy has a positive influence on CO₂ emissions. Thus, it suggests that any increased consumption of non-renewable energy will lead to increase CO₂ emissions. These outcomes are constant with Dogan and Ozturk (2017). In contrast, the outcomes show that estimation coefficient of renewable energy has an inverse and statistically significant influent on CO₂ emissions in Turkey. These outcomes are in line with Boluk and Mert (2015) and Dogan and Ozturk (2017). Thus, the outcomes confirm that if there is any increase in consumption of renewable energy, this will lead to reduce Turkey carbon emissions. However, these outcomes confirm that Turkey needs to lead in renewable energy resources in order to sustainable economic development, which in turn it will lead to decrease environmental pollution.

Moreover, the findings of this research indicate that financial development in Turkey affect positively carbon emission in Turkey. These outcomes are constant with Haseeb et al. (2018) and siksai et al, (2019). These outcomes confirm that the financial development can affect the demand and consumption of energy in several ways such as the improved financial system enables consumers to borrow for their personal needs, which in turn leads to increase consumption of energy and CO₂ emissions.

Table 5 The coefficients of ARDL, D-OLS, F-MOLS, and CCR Models in long run.

Variable	ARDL	D-OLS	FM-OLS	CCR
LnGDP	1.310**	1.210**	1.185	3.110**
lnGDP2	-0.910*	-0.510**	-0.141	-0.310**
lnFSD	0.115*	0.310**	0.398	0.118**
lnREC	-0.112*	-0.898*	-0.331	-0.182*
lnNREC	1.132***	1.331***	1.419***	1.019***
R ²	0.96	0.97	0.97	0.98

*,**,*** symbolize the significance of tested variables at 1%, 5%, 10% level, respectively.

The ECM model results are showed in Table 6. where $\ln CO_2$ is the dependent tested variable, were -0.511, which is negative and statistically significant at 1% level. The short-term coefficient of non-renewable energy is positive, in contrast, the short-term coefficient of renewable energy is negative.

Table 6 The coefficients of ARDL in the short run

Variable	Coeff.	t-statistics
$\Delta \ln GDP$	1.001**	-7.881
$\Delta \ln GDP^2$	-0.555*	-1.195
$\Delta \ln FSD$	0.193**	1.004
$\Delta \ln REC$	-0.030	-2.994
$\Delta \ln NREC$	1.108***	-6.004
ECT_{t-1}	-0.511***	-2.452

*,**,*** symbolize significance of tested variables at 1%,5%, and 10% Level

respectively

To confirm if the model is correctly formulated, the paper employs the *Normality, Breusch – Pagan Godfrey, ARCH, LM, and Ramsey – Reset tests*. The outcomes confirm that the model is correctly formulated. The findings show that the tested model of this study has a normal distribution, and there is no autocorrelation. Moreover, the study model is stable.

Table 7: Diagnostic test results for ARDL

	P-value
–Serial correlation (LM)	0.440(0.551)
–Heteroscedasticity	1.200(0.510)
–Normality test	1.701(0.382)
–ARCH Test	1.103(0.810)
–Stability Ramsey test	1.315(0.111)

5. CONCLUSION

The financial sector in Turkey experienced a positive development from 2001 to 2015; for example, it experienced rapid growth in total assets during over this period, the credits provided by the financial

institutions and banks to the private-sectors increased from 11.79% of GDP in 2001 to 50% in 2014, thus the energy consumption of Turkey is perpetually increasing, which in turn may lead to increase the environment population. Hence, it's highly important to test the impact of the financial sector development on the environmental population in Turkey. In this regard, this study aims to test of financial sector development, non-renewable energy consumption, renewable energy consumption, and the GDP Turkey carbon dioxide emissions over the tested 1985 to 2015. To provide new evidence to the literature, the paper uses the newly version of (ARDL) testing approach as suggested by (McNown et al. 2018), and a new version of combined co-integration as proposed by Bayer and Hanck(2013) to provide strong evidence that the co-integration amongst tested variables is valid. The ARD, D-OLS, FM-OLS, and CCR models are used to test a long-run interaction amongst the tested variables.

The outcomes from ARDL, D-OLS, FM-OLS, CCR models show the financial sector development coefficients have a positive influence on Turkey's carbon emissions in the long-run level. Hence, an increase in the credits from the banks and financial institutions to the markets will lead to support and increase the investment and the projects in Turkey. Which in turn leads to a raise in nonrenewable energy consumption and CO₂ emissions. This outcome confirms the development of the financial sector can affect the demand and consumption of energy in several ways such as the improved financial system enables consumers to borrow for their personal needs, which in turn leads to an increase in consumption of energy and CO₂ emissions. This research suggests the influence of financial sector development on carbon emission depends on how this variable affected economic growth. In this respect any improvement in the financial sectors such as a raise in the credits from the financial institutions and banks to the markets, it may lead to promote the projects and investment and, improve the risk management systems, which may lead to affect economic growth and consumption of energy. Hence, it may leads to an increase in CO₂ emission.

On other hand, the outcomes show that the coefficient of non-renewable energy has a positive influence on Turkey's CO₂ emissions. Thus, it suggests that any increase in the consumption of non-renewable energy will lead to an increase in Turkey's CO₂ emissions. These outcomes are constant with Dogan and Ozturk (2017). In contrast, the outcomes demonstrate that the estimation coefficient of renewable energy has an inverse and statistically significant influent on CO₂ emissions in Turkey. These outcomes are in line with Boluk and Mert (2015) and Dogan and Ozturk (2017). Thus, the outcomes confirm that an increase in renewable energy consumption will reduce environmental pollution in Turkey. The paper suggests that the governments of Turkey should design policies to decrease the costs of renewable resources, and the policy makers of Turkey need to increase the role of green energy and reduce the oil consumption, this can be considered a good solution to reduce the carbon emissions.

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