Export Product Diversification and the Environmental Kuznets Curve: Evidence from Turkey

Gozgor, Giray and Can, Muhlis

Istanbul Medeniyet University, Hakkari University

27 February 2016

Export Product Diversification and the Environmental Kuznets Curve: Evidence from Turkey

Abstract

Countries try to stabilize the demand for energy on one hand and sustain economic growth on other, but the worsening global warming and climate change problems have put pressure on them. This paper estimates the environmental Kuznets curve over the period 1971–2010 in Turkey both in the short and the long run. For this purpose, the unit root test with one structural break and the cointegration analysis with multiple endogenous structural breaks are used. The effects of energy consumption and export product diversification on CO_2 emissions are also controlled in the dynamic empirical models. It is observed that the environmental Kuznets curve hypothesis is valid in Turkey in both the short run and the long run. The positive effect of energy consumption on CO_2 emissions is also obtained in the long run. In addition, it is found that a greater product diversification of exports yields higher CO_2 emissions in the long run. Inferences and policy implications are also discussed.

Keywords: environmental Kuznets curve; energy consumption; export product diversification; time series modeling; structural breaks

JEL Codes: Q56; O13; C32

1. Introduction

Countries try to stabilize the demand for energy on one hand and sustain economic growth on other, but the worsening global warming and climate change problems have put pressure on them (Saboori and Sulaiman, 2013). In recent years, countries have put serious efforts to take measures to tackle environmental degradation through agreements (Ozcan, 2013). Since evidence shows a serious global warming problem, scholars have also intensified their interest in empirical studies related to the environment, and the main interest of these studies is the economic growth–environmental quality nexus (Narayan and Narayan, 2010).

The environmental Kuznets curve hypothesis is used to investigate the relationship between environmental degradation (measured by CO_2 emissions per capita in general) and economic growth. According to the environmental Kuznets curve hypothesis, environmental degradation increases as a country grows economically. This situation continues until the country reaches a high level of income. When the country reaches a certain level of income, CO_2 emissions decline (Kearsly and Riddel, 2010; Narayan and Narayan, 2010; Song et al., 2008). The main goal of countries at the first stage of economic development is to increase their development level, that is, to increase their output level and to create new job opportunities. In this process, environmental quality has a "secondary importance" (Onafowora and Owoye, 2014). In addition, achieving a certain (high income) level does not necessarily mean that CO_2 emissions in a country will decrease (Pao and Tsai, 2010). In other words, policy makers should take the necessary implications into account in reducing environmental degradation.

The environmental Kuznets curve hypothesis was first introduced and empirically tested by Grossman and Kruger (1995). Empirical studies conducted after Grossman and Kruger (1995) emphasize that three different mechanisms affect the environmental Kuznets curve: scale effect, structural effect, and technique effect (Song et al., 2008). First, observing the emergence of the detrition in environmental parameters (scale effect) is possible. Afterward, through structural and technique effects, there should be a decline in factors causing environmental degradation. The most important cause of structural and technique effects is the use of cleaner technology in production (Kanjilal and Ghosh, 2013).

Research studies on environmental degradation can be grouped into three main categories.[1] The first group focuses on the direct relationship between environmental degradation and economic growth (e.g., Dinda and Coondoo, 2006; Fodha and Zaghdoud, 2010; Friedl and Getzner, 2003; Heil and Selden, 1999; Narayan and Narayan, 2010; Romero–Avila, 2008; Song

[1] Besides, some studies focus on the energy consumption–economic growth nexus. For a detailed review of the literature, see, for example, Omri (2014), Ozturk (2010), and Payne (2010).

et al., 2008; Yang et al., 2015). The second group analyzes the relationships between environmental degradation, economic growth, and energy consumption (e.g., Ang, 2008; Apergis and Payne, 2009; Bilgili et al., 2016; Lean and Smyth, 2010; Ozcan, 2013; Pao and Tsai, 2010; Saboori and Sulaiman, 2013; Soytas et al., 2007). The third group studies the relationships between environmental degradation, economic growth, and energy consumption while controlling other explanatory variable(s). In these studies, employment, financial development, fixed capital formation, foreign direct investments, population density, tourism, trade openness, and urbanization are used as explanatory variables in analyzing their effects on environmental degradation (e.g., Akbostanci et al., 2009; Ang, 2009; Bento and Mountinho, 2016; Halicioglu, 2009; Javid and Sharif, 2016; Jayanthakumaran et al., 2012; Jebli et al., 2016; Kanjilal and Ghosh, 2013; Katircioglu, 2014; Managi and Jena, 2008; Nasir and Rehman, 2011; Onafowora and Owoye, 2014; Soytas and Sari, 2009; Tang and Tan, 2015; Wang et al., 2015; Zhang and Cheng, 2009).

Our study belongs to the third group. Indeed, the control variables of the environmental Kuznets curve hypothesis in the third group remarkably have identical features. For instance, some of these studies use exports, imports, and trade openness as a proxy for international trade in both developed and developing countries (e.g., Bento and Moutinho, 2016, for Italy; Halicioglu, 2009, for Turkey; Jayanthakumaran et al., 2012, for China and India). However, not only the volume of trade but also the diversity of export products can significantly affect CO_2 emissions since efforts to add new products into the export basket can lead to a hike in CO_2 emissions. In this context, the aim of our study is to investigate the dynamic relationships between CO_2 emissions, export product diversification, energy consumption, and per capita gross domestic product (GDP) in Turkey, where the export-led (oriented) growth strategy has been adopted. To the best of our knowledge, this is the first study that investigates the dynamic relationships between income, energy consumption, and CO_2 emissions while controlling the effects of export product diversification within the context of the environmental Kuznets curve hypothesis.

Indeed, export product diversification is one of the most important issues in the international trade literature (Agosin et al., 2012). This topic has been evaluated in the context of developing countries in particular, and one of the most important problems in developing countries is that they have a narrow export basket (Hesse, 2008). In general, the export baskets of developing economies consist of traditional products, and these countries are making an effort to widen their diversification by adding nontraditional products into their export baskets (De Pineres and Ferrantino, 1997).

Studies on export product diversification mainly investigate the relationship between diversification and economic growth, and most of them have concluded that export product diversification has a significant contribution to economic growth (e.g., Aditya and Acharrya, 2013; Al–Marhubi, 2000; De Pineres and Ferrantino, 1997; Herzer and Nowak–Lehmann, 2006; Hesse, 2008). It is important to note that the diversification of export products emerges at the first stage of the development effort, and the process continues until the country reaches a particular income level (Cadot et al., 2011). Following this process, that is, at the second stage, the country focuses on export concentration rather than diversification after a turning point. In other words, there is an inverted U relationship between export product diversification and income (Imbs and Wacziarg, 2003). This turning point is calculated to be $22,500 by Klinger and Lederman (2006) and $25,000 by Cadot et al. (2011).

During the process of diversifying the export basket, observing more CO_2 emissions in developing countries is highly possible. Diversifying the export basket may also result in an increase in energy consumption since energy plays a significant role in reaching sustainable economic growth, which means a rise in macroeconomic activity. Increasing the macroeconomic activity will bring about higher energy consumption, and energy consumption can lead to environmental degradation (Onafowora and Owoye, 2014). At this point, this paper empirically shows that not only economic growth and energy consumption but also export product diversification matter for CO_2 emissions in Turkey over the period 1971–2010.

The remainder of the paper is organized as follows: Section 2 explains the data and empirical model and discusses the econometric methodology. Section 3 reports the empirical results. Section 4 discusses the findings and policy implications. Section 5 concludes.

2. Data, Empirical Model, and Econometric Methodology

2.1. Data

This paper uses CO_2 emissions (metric tons per capita) over the period 1971–2010 in Turkey as the dependent variable. The real (constant $ price in 2005) GDP per capita and the squared real GDP per capita (constant $ price in 2005) are used to capture the linear and nonlinear effects of income, respectively. Energy consumption (kilogram of oil equivalent) per capita is also considered in the empirical model. All of these variables are used in logarithmic form in the empirical analyses. The frequency of the data is annual. The source of the related data is the World Development Indicators (WDI) of the World Bank.

The data on the diversification of exports are obtained from the database of the International Monetary Fund (IMF). The related data set has recently been compiled by the IMF staff, and it considers indexes of diversification across products and trading partners (market or destination). Here, the product diversification index (Theil index) is the benchmark measure of the diversification of a country's exports. In addition, a higher value of the Theil index means a lower export product diversification.[2] Since the benchmark model is defined in logarithmic form, the export product diversification index is also considered in logarithmic form. Finally, a summary of the descriptive statistics is reported in Appendix I.

2.2. Empirical Model

In this paper, a standard environmental Kuznets curve model in the literature is used; and income, squared income, and energy consumption are considered the main determinants of CO_2 emissions (e.g., Ang, 2008; Bilgili et al., 2016; Ozcan, 2013; Pao and Tsai, 2010; Saboori and Sulaiman, 2013; Soytas and Sari, 2009; Soytas et al., 2007; Zhang and Cheng, 2009). Income effect is measured by the level real GDP per capita and the squared real GDP per capita, and energy effect is captured by the energy consumption per capita. We also suggest that export product diversification can also be a significant determinant of CO_2 emissions. Therefore, the following empirical model for the environmental Kuznets curve can be written as such:

$$CO_{2t} = f(RGDP_t^{\alpha_1}, SRGDP_t^{\alpha_2}, ENC_t^{\alpha_3}, EXPDIV_t^{\alpha_4}) \tag{1}$$

The empirical model in Equation (1) can be expressed in logarithmic form as such:

$$\log CO_{2t} = \alpha_0 + \alpha_1 \log RGDP_t + \alpha_2 \log SRGDP_t + \alpha_3 \log ENC_t + \alpha_4 \log EXPDIV_t + \varepsilon_t \tag{2}$$

In Equations (1) and (2), $\log CO_{2t}$ is CO_2 emissions in logarithmic form at time *t*, $\log RGDP_t$ and $\log SRGDP_t$ are the level and the squared real GDP per capita in logarithmic form at time *t*, $\log ENC_t$ is the energy consumption per capita in logarithmic form at time *t*; $\log EXPDIV_t$ is the export diversification index in logarithmic form at time *t*. The error term is also denoted by ε_t.

It should be expected that $\alpha_1 > 0$, $\alpha_2 < 0$, and $\alpha_3 > 0$. Actually, this is the main hypothesis of the paper: The environmental Kuznets curve hypothesis suggests that $\alpha_1 > 0$ and it is elastic, as well as $\alpha_2 < 0$, and both coefficients should be obtained as statistically significant. Otherwise, it can be said that there is no valid CO_2 emissions function in the country; that is, there is a no significant inference for environmental pollution (Halicioglu, 2009). In addition, a greater energy consumption should yield a higher economic activity and should hike CO_2 emissions in

[2] In other words, finding the diversification of exports to positively contribute to CO_2 emissions implies that the relationship between two variables is negative. The positive sign implies that the concentration of exports positively contributes to CO_2 emissions. We refer to Papageorgiou and Spatafora (2012) for the technical details and calculation method of the export product diversification (Theil) index.

a developing economy. As we have discussed in the introduction, the effect of export diversification α_4 on CO_2 emissions can be either positive or negative since it depends on the economic development stage of a country: it should be expected that in a developing country export basket provides pollution-intensive goods, and diversifying its export basket leads to greater CO_2 emissions. However, as a country develops, it starts to exclude these goods from the export basket (probably it will import these goods from other countries with "less-restrictive environmental protection laws"). So as a country's export basket sophisticates, lower CO_2 emissions are produced in the case of a developed country. It is important to note that the key point here is to obtain a statistically significant (long-run) coefficient.

On the other hand, reaching a long-run equilibrium can take time for CO_2 emissions in Turkey. In such case, the speed of adjustment between short-run and long-run CO_2 emissions can also be modeled by the following error correction model (ECM):

$$\begin{aligned}\Delta \log CO_{2t} &= \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta \log CO_{2t-k} + \sum_{i=0}^{n} \alpha_2 \Delta \log RGDP_{t-k} + \sum_{i=0}^{n} \alpha_3 \Delta \log SRGDP_{t-k} \\ &+ \sum_{i=0}^{n} \alpha_4 \Delta \log ENC_{t-k} + \sum_{i=0}^{n} \alpha_5 \Delta \log EXPDIV_{t-k} + \alpha_6 \varepsilon_{t-1} + \mu_t \end{aligned} \tag{3}$$

In Equation (3), Δ indicates the change in both dependent and independent variables, and μ_t is the error term. In addition, ε_{t-1} is the lagged error correction term (ECT) obtained from the estimation of Equation (2), and it represents the speed of adjustment of the disequilibrium between short-run and long-run levels of CO_2 emissions. It is expected that $\alpha_6 <0$.

2.3. Econometric Methodology

First, the unit root test of Lee and Strazicich (2013), which accounts for one endogenous structural break in the series, is implemented. To successfully implement the cointegration analysis, finding a statistically significant unit root in all (five) variables is necessary.

Second, the cointegration test of Maki (2012), which considers the structural breaks in the level and regime shifts, is run. The null hypothesis of the test is "there is no cointegration among the series," and the alternative hypothesis is "cointegration with *i* breaks." The critical values are generated by the Monte Carlo simulations in Maki (2012). In addition, the maximum number of structural breaks is selected as two events. The most important feature of the cointegration test of Maki (2012) is considering each period as a potential structural break point. In other words, the test statistics of the cointegration test of Maki (2012) is defined to determine the endogenous structural break(s).

At this stage, Maki (2012) offers four different models to analyze the cointegrating relationships between the variables. These models can be written as follows:

Model 1 considers the structural break(s) in the level (intercept) without the time trend:

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \beta x_t + \upsilon_t \tag{4}$$

Model 2 considers the structural break(s) in the level (intercept) and the coefficients without the time trend:

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \beta x_t + \sum_{i=1}^{k} \beta_i x_i K_{i,t} + \upsilon_t \tag{5}$$

Model 3 considers the structural break(s) in the level (intercept) and the coefficients with the time trend:

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \gamma x + \beta x_t + \sum_{i=1}^{k} \beta_i x_i K_{i,t} + \upsilon_t \tag{6}$$

Model 4 considers the structural break(s) in the level (intercept), the coefficients, and the time trend:

$$y_t = \mu + \sum_{i=1}^{k} \mu_i K_{i,t} + \gamma t + \sum_{i=1}^{k} \gamma_i t K_{i,t} + \beta x_t + \sum_{i=1}^{k} \beta_i x_i K_{i,t} + \upsilon_t \tag{7}$$

In Equations (4) to (7), $K_{i,t}$ is the dummy variable, and if the test statistics is greater than the critical value, $K_{i,t}$=1; otherwise, it will be equal to zero ($K_{i,t}$=0). μ_i is the constant (intercept), γ is the coefficient, β is the time trend, and υ_t is the error terms.

Since the results of the unit rest test considers the break in the level and they indicate significant I(1) for all variables, the cointegration test of Maki (2012) that models the break in the level is used. In other words, *model 1* (structural break(s) in the level (intercept) without the time trend) is used within the cointegration test methodology of Maki (2012).

Third, the long-run coefficients of the model that is represented in Equation (2) are estimated with the dynamic ordinary least squares (DOLS) of Stock and Watson (1993) with the heteroskedasticity and autocorrelation consistent (HAC) standard errors (Bartlett kernel, Newey-West fixed bandwidth = 4.0000). Two structural break dates are also included, and the selection of structural break dates is based on the results of *model 1* of the cointegration test of Maki (2012).

Fourth, the ECM for the short-run coefficient is estimated for the empirical model expressed in Equation (3).

Fifth, the Granger causality/block exogeneity Wald tests are run, and the test procedure can be identified as follows:

$$\begin{bmatrix} \Delta\log CO_{2t} \\ \Delta\log RGDP_t \\ \Delta\log SRGDP_t \\ \Delta\log ENC_t \\ \Delta\log EXPDIV_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \\ \mu_4 \\ \mu_5 \end{bmatrix} + \begin{bmatrix} \lambda_{11,1} & \lambda_{12,1} & \lambda_{13,1} & \lambda_{14,1} & \lambda_{15,1} \\ \lambda_{21,1} & \lambda_{22,1} & \lambda_{23,1} & \lambda_{24,1} & \lambda_{25,1} \\ \lambda_{31,1} & \lambda_{32,1} & \lambda_{33,1} & \lambda_{34,1} & \lambda_{35,1} \\ \lambda_{41,1} & \lambda_{42,1} & \lambda_{43,1} & \lambda_{44,1} & \lambda_{45,1} \\ \lambda_{51,1} & \lambda_{52,1} & \lambda_{53,1} & \lambda_{54,1} & \lambda_{55,1} \end{bmatrix} \begin{bmatrix} \Delta\log CO_{2t-1} \\ \Delta\log RGDP_{t-1} \\ \Delta\log SRGDP_{t-1} \\ \Delta\log ENC_{t-1} \\ \Delta\log EXPDIV_{t-1} \end{bmatrix} +$$

$$\ldots + \begin{bmatrix} \lambda_{11,k} & \lambda_{12,k} & \lambda_{13,k} & \lambda_{14,k} & \lambda_{15,k} \\ \lambda_{21,k} & \lambda_{22,k} & \lambda_{23,k} & \lambda_{24,k} & \lambda_{25,k} \\ \lambda_{31,k} & \lambda_{32,k} & \lambda_{33,k} & \lambda_{34,k} & \lambda_{35,k} \\ \lambda_{41,k} & \lambda_{42,k} & \lambda_{43,k} & \lambda_{44,k} & \lambda_{45,k} \\ \lambda_{51,k} & \lambda_{52,k} & \lambda_{53,k} & \lambda_{54,k} & \lambda_{55,k} \end{bmatrix} \begin{bmatrix} \Delta\log CO_{2t-k} \\ \Delta\log RGDP_{t-k} \\ \Delta\log SRGDP_{t-k} \\ \Delta\log ENC_{t-k} \\ \Delta\log EXPDIV_{t-k} \end{bmatrix} + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \\ \delta_5 \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \\ \varepsilon_{5,t} \end{bmatrix} \tag{8}$$

In Equation (8), ECT_{t-1} is the lagged error correction term obtained from the long-run equilibrium model. $\varepsilon_{1,t}$, $\varepsilon_{2,t}$, $\varepsilon_{3,t}$, $\varepsilon_{4,t}$, and $\varepsilon_{5,t}$ indicate the independent and identically distributed random errors, and they are defined within a finite covariance matrix with mean zero.

3. Empirical Results

First, the results for the unit root test of Lee and Strazicich (2013) are reported in Table 1 for each of the five variables. The results here are considered for the structural break in the level.

[Insert Table 1]

The results in Table 1 indicate that all variables contain a unit root at a statistical significance level of 5% and the difference among them is stationary. In other words, all variables can be defined as I(1) process. Therefore, it is observed that all variables in the empirical model are suitable for the cointegration technique.

Second, the results of the cointegration test of Maki (2012) are reported in Table 2.

[Insert Table 2]

The results of the four models of the cointegration test of Maki (2012) in Table 2 indicate that the cointegration of log CO_2 emissions – log GDP per capita – log squared GDP per capita – log energy consumption – log export diversification is statistically significant at 1% level. Therefore, the short-run and long-run coefficients can be obtained.

The results of the DOLS estimations for long-run coefficients are reported in Table 3. As expected, the long-run coefficients of the log real GDP per capita are positive and elastic (4.54), and the long-run coefficients of the log squared log real GDP per capita are negative and inelastic (–0.55). In addition, the long-run coefficients of the log energy consumption per capita are also positive and inelastic (0.71), as expected. The effects of related variables are statistically significant at 1% level; however, the coefficients of the structural break dates are not statistically significant.

[Insert Table 3]

The effect of the log export product diversification (Theil index) on the log CO_2 emissions is also found to be negative and inelastic (–0.03), and that means export diversification yields higher CO_2 emissions. The long-run coefficient of the log export product diversification is obtained as statistically significant at the 5% level. In other words, the results in Table 3 indicate that one standard deviation decreases in the Theil index (i.e., higher export product diversification), which leads to a 0.7% rise (approx. 1.05 metric tons per capita) in CO_2 emissions in Turkey over the long run.

The results of the ECM are reported in Table 4. Now, the effects of the lagged log real GDP per capita and the lagged log squared real GDP per capita on CO_2 emissions are positive and elastic (14.46) and negative and elastic (–2.007), respectively. In addition, their short-run coefficients are found to be statistically significant at the 5% level. The positive and inelastic coefficients for the lagged CO_2 emissions (0.25) and the lagged log energy consumption per capita (0.11) are also obtained; however, their short-run coefficients are found to be statistically insignificant.

[Insert Table 4]

The ECT term of the ECM regression is −0.263, and it is found to be statistically significant at the 5% level. Here, the negative sign implies that CO_2 emissions in Turkey converges to its long-run equilibrium path by a speed of adjustment of 26.3% through the channels of the real GDP per capita, squared real GDP per capita, energy consumption per capita, and export product diversification (Theil) index.

The short-run impact of the log export diversification (Theil) index on the log CO_2 emissions is found to be –0.033, but the coefficient is not statistically significant in the short run. Finally, the results of the Granger causality/block exogeneity Wald tests are reported in Table 5.

[Insert Table 5]

The results in Table 5 indicate that a statistically significant causal relationship runs from the log real GDP per capita and the log squared real GDP per capita to the log CO_2 emissions in the short run. These results are in line with the results of ECM estimations for the short-run coefficients. In addition, the overall chi-square test statistics of the causality relationship for the log CO_2 emissions is also statistically significant. These results are in line with the results of the DOLS estimations for long-run coefficients. Therefore, the results of the Granger causality/block exogeneity Wald tests show that previously obtained empirical results for both the short run and the long run are statistically robust in modeling CO_2 emissions in Turkey.

In addition, it is observed that a statistically significant causal relationship runs from the log CO_2 emissions, log real GDP per capita, and log squared real GDP per capita to the log energy consumption per capita in the short run. Plus the overall chi-square test statistics of the causality relationship for the log energy consumption per capita is also statistically significant. Therefore, it is found that income per capita causes energy consumption in a direct way, and income causes energy consumption indirectly through CO_2 emissions in Turkey. Plus the causal effect of income per capita is found to be nonlinear.

4. Discussion and Policy Implications

4.1. Discussion

The empirical results in the paper show that income, energy consumption, and export product diversification are the main variables in explaining CO_2 emissions in Turkey in the long run. Conclusively, the empirical results show that the environmental Kuznets curve hypothesis is valid in Turkey over the period under concern. It is observed that income is the most important variable in explaining CO_2 emissions in Turkey since its effect is statistically significant in both the short run and the long run. Besides, there is an inverted U relationship between income and CO_2 emissions in Turkey; that is, empirical evidence for the validity of the environmental Kuznets curve hypothesis illustrates that the level of CO_2 emissions increases with income at first until they reach stabilization. Then, they reduce in the long run. It is also found that energy consumption is positively related to CO_2 emissions in Turkey in the long run, as expected in the case of a developing country.[3] These empirical results on the effects of income and energy consumption on CO_2 emissions are in line with the previous empirical results of studies on several developing countries (e.g., Halicioglu, 2009, for Turkey; Javid and Sharif, 2016, for Pakistan; Jayanthakumaran et al., 2012, for China and India; Kanjilal and Ghosh, 2013, for India; Managi and Jena, 2008, for India; Nasir and Rehman, 2011, for Pakistan; Tang and Tan, 2015, for Vietnam). In other words, the CO_2 emissions function with energy consumption is valid in Turkey, and this result is in line with the previous findings of Halicioglu (2009) in particular. These results mean that forecasting future CO_2 emissions from past levels of income, energy consumption, and export diversification is possible.

[3] Note that the long-run elasticity of energy consumption for CO_2 emissions is found to be 0.71 in the paper for the period 1971–2010. Similarly, this coefficient is obtained to be 0.78 in Halicioglu (2009) for the period 1960–2005.

Finally, it is also observed that the wider product diversification in export basket yields higher CO_2 emissions in Turkey in the long run. However, the short-run effect is found to be statistically insignificant. To the best of our knowledge, these are the first empirical results on the effect of export basket diversification on CO_2 emissions in the literature.

4.2. Policy Implications

Empirical findings show that there could be some environmental policy implications that would suppress CO_2 emissions. First, it is observed that rapid economic growth leads to a hike in environmental pollutants. However, sustainable economic growth is crucial for any developing economy not only for catching up with developed economies but also for creating new job opportunities, especially for young people. So in developing economies, as income increases, CO_2 emissions systematically increase as well. At this point, policy implications should focus on reducing the initial costs of environmentally friendly investments.

Second, given that Turkey is still a net energy importer and energy consumption increases as per capita income increases, reducing the level of energy consumption is also not feasible. Here, policy implications should be based on supporting the more efficient use of renewable energy in the Turkish economy. It should be noted that investment or tax incentives on technologies that consume renewable energy can be noteworthy policy tools.

Third, another issue is the efficient use of nuclear energy in the production process. Indeed, nuclear energy can reduce the consumption of fossil energy sources; therefore, it can suppress CO_2 emissions in Turkey. It can be suggested that policy implications on nuclear energy can provide significant results in reducing CO_2 emissions in Turkey.

Fourth, results from this paper also indicate that export product diversification significantly affects CO_2 emissions in Turkey. Indeed, it is found that the product diversification of exports can be beneficial not only for rapid economic growth but also for environmental pollutant management. For instance, firms should avoid producing goods that cause severe CO_2 emissions. This issue should be assessed in widening the export basket, and products with high CO_2 emissions can be imported. Of course, all of these policy implications require a detailed knowledge on the scale of environmental pollutants for each sector in the Turkish economy (Tunc et al., 2007).

5. Conclusion

In recent years, countries have put serious efforts to take measures to tackle environmental degradation through agreements. Since evidence shows a serious global warming problem, scholars have also intensified their interest in empirical studies related to the environment, and the main interest of these studies is the economic growth–environmental quality nexus. In this paper, the validity of the environmental Kuznets curve hypothesis in the Turkish economy is analyzed for the period 1971–2010. To do so, the unit root test of Lee and Strazicich (2013) and the cointegration analysis of Maki (2012), which is assumed to have endogenous structural breaks in time series, are used. By using the ECM and the DOLS estimation techniques, the short-run and the long-run coefficients are also obtained. In addition, the effects of energy consumption and export product diversification on CO_2 emissions are also controlled in the dynamic empirical models. In other words, this paper investigates the dynamic relationships between CO_2 emissions, export product diversification, energy consumption, and per capita gross domestic product (GDP) in Turkey, where the export-led (oriented) growth strategy has been adopted. To the best of our knowledge, this is the first study that investigates the dynamic relationships between income, energy consumption, and CO_2 emissions while controlling the effects of export product diversification within the context of the environmental Kuznets curve hypothesis.

The findings of this paper are threefold: First, it is observed that the environmental Kuznets curve hypothesis is valid in Turkey in both the short run and the long run over the period under concern. Second, the positive but inelastic impact of energy consumption on CO_2 emissions is also obtained in the long run. Third, it is observed that a higher product diversification of exports yields higher CO_2 emissions in Turkey in the long run; and actually, this is the novel contribution of the paper to the existing empirical literature.

Future research on the effects of export diversification (product and trading partner diversification) on CO_2 emissions and energy consumption can be conducted in other developing or developed countries. In addition, the effects of the sub-indexes of the export diversification (Theil) index (e.g., extensive margin and intensive margin) can also be considered within this context with different econometric tools.

References

[1] Aditya, A, Acharyya, R. Export diversification, composition, and economic growth: evidence from cross–country analysis. Journal of International Trade and Economic Development 2013; 22(7): 959–92.

[2] Agosin, MR, Alvarez, R, Bravo–Ortega, C. Determinants of export diversification around the world: 1962–2000. World Economy 2012; 35(3): 295–315.

[3] Akbostanci, E, Turut–Asik, S, Tunc, GI. The relationship between income and environment in Turkey: is there an Environmental Kuznets Curve? Energy Policy 2009; 37(3): 861–7.

[4] Al–Marhubi, F. Export diversification and growth: an empirical investigation. Applied Economics Letters 2000; 7(9): 559–62.

[5] Ang, JB. CO_2 emissions, research, and technology transfer in China. Ecological Economics 2009; 68(10): 2658–65.

[6] Ang, JB. Economic development, pollutant emissions and energy consumption in Malaysia. Journal of Policy Modeling 2008; 30(2): 271–8.

[7] Apergis, N, Payne, JE. Energy consumption and economic growth in Central America: evidence from a panel cointegration and error correction model. Energy Economics 2009; 31(3): 211–6.

[8] Bento, JPC, Moutinho, V. CO_2 emissions, non-renewable and renewable electricity production, economic growth and international trade in Italy. Renewable and Sustainable Energy Reviews 2016; 55: 142–55.

[9] Bilgili, F, Koçak, E, Bulut, U. The dynamic impact of renewable energy consumption on CO_2 emissions: a revisited Environmental Kuznets Curve approach. Renewable and Sustainable Energy Reviews 2016; 54: 838–45.

[10] Cadot, O, Celine, C, Strauss–Kahn, V. Export diversification: what's behind the hump? Review of Economic and Statistics 2011; 93(2): 590–605.

[11] De Pineres, SAG, Ferrantino, M. Export diversification and structural dynamics in the growth process: the case of Chile. Journal of Development Economics 1997; 52(2): 375–91.

[12] Dinda, S, Coondoo, D. Income and emissions: a panel data-based cointegration analysis. Ecological Economics 2006; 57(2): 167–81.

[13] Fodha, M, Zaghdoud, O. Economic growth and pollutant emissions in Tunisia: an empirical analysis of the Environmental Kuznets Curve. Energy Policy 2010; 38(2): 1150–6.

[14] Friedl, B, Getzner, M. Determinants of CO_2 emissions in a small open economy. Ecological Economics 2003; 45(1): 133–48.

[15] Grossman, GM, Krueger, AB. Economic growth and the environment. Quarterly Journal of Economics 1995; 110(2): 353–77.

[16] Halicioglu, F. An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy 2009; 37(3): 1156–64.

[17] Heil, MT, Selden, TM. Panel stationarity with structural breaks: carbon emissions and GDP. Applied Economics Letters 1999; 6(4): 223–5.

[18] Herzer, D, Nowak–Lehmann, FD. What does export diversification do for growth? An econometric analysis. Applied Economics 2006; 38(15): 1825–38.

[19] Hesse, H. Export diversification and economic growth. International Bank for Reconstruction and Development / the World Bank Commission on Growth and Development Working Paper, No. 21, 2008, Washington, D.C.: World Bank.

[20] Imbs, J, Wacziarg, R. Stages of diversification. American Economic Review 2003; 93(1): 63–86.

[21] Javid, M, Sharif, F. Environmental Kuznets Curve and financial development in Pakistan. Renewable and Sustainable Energy Reviews 2016; 54: 406–14.

[22] Jayanthakumaran, K, Verma, R, Liu, Y. CO_2 emissions, energy consumption, trade and income: a comparative analysis of China and India. Energy Policy 2012; 42: 450–60.

[23] Jebli, MB, Youssef, SB, Ozturk, I. Testing environmental Kuznets Curve hypothesis: the role of renewable and non-renewable energy consumption and trade in OECD countries. Ecological Indicators 2016; 60: 824–31.

[24] Kanjilal, K, Ghosh, S. Environmental Kuznets's Curve for India: evidence from tests for cointegration with unknown structural breaks. Energy Policy 2013; 56: 509–15.

[25] Katircioglu, ST. Testing the tourism-induced EKC hypothesis: the case of Singapore. Economic Modelling 2014; 41: 383–91.

[26] Kearsley, A, Riddel, M. A further inquiry into the pollution haven hypothesis and the Environmental Kuznets Curve. Ecological Economics 2010; 69(4): 905–19.

[27] Klinger, B, Lederman, D. Diversification, innovation, and imitation inside the global technology frontier. World Bank Policy Research Working Paper, No. 3872, 2006, Washington, D.C.: World Bank.

[28] Lean, HH, Smyth, R. CO_2 emissions, electricity consumption and output in ASEAN. Applied Energy 2010; 87(6): 1858–64.

[29] Lee, J, Strazicich, MC. Minimum LM unit root test with one structural break. Economics Bulletin 2013; 33(4): 2483–92.

[30] Maki, D. Tests for cointegration allowing for an unknown number of breaks. Economic Modelling 2012; 29(5): 2011–5.

[31] Managi, S, Jena, PR. Environmental productivity and Kuznets Curve in India. Ecological Economics 2008; 65(2): 432–40.

[32] Narayan, PK, Narayan, S. Carbon dioxide emission and economic growth: panel data evidence from developing countries. Energy Policy 2010; 38(1): 661–6.

[33] Nasir, M, Rehman, FU. Environmental Kuznets Curve for carbon emissions in Pakistan: an empirical investigation. Energy Policy 2011; 39(3): 1857–64.

[34] Omri, A. An international literature survey on energy–economic growth nexus: evidence from country-specific studies. Renewable and Sustainable Energy Reviews 2014; 38: 951–9.

[35] Onafowora, OA, Owoye, O. Bound testing approach to analysis of the Environment Kuznets Curve hypothesis. Energy Economics 2014; 44: 47–62.

[36] Ozcan, B. The nexus between carbon emissions, energy consumption and economic growth in Middle East countries: a panel data analysis. Energy Policy 2013; 62: 1138–47.

[37] Ozturk I. A literature survey of energy growth nexus. Energy Policy 2010; 38(1): 340–9.

[38] Pao, H–T, Tsai, C–M. CO_2 Emissions, energy consumption and economic growth in BRIC countries. Energy Policy 2010; 38(12): 7850–60.

[39] Papageorgiou, C, Spatafora, N. Economic diversification in LICs: stylized facts and macroeconomic implication. IMF Staff Discussion Notes 12/13, 2012, Washington, D.C.: International Monetary Fund.

[40] Payne JE. A survey of the electricity consumption–growth literature. Applied Energy 2010; 87(3): 723–31.

[41] Romero–Avila, D. Questioning the empirical basis of the environmental Kuznets curve for CO_2: new evidence from a panel stationary test robust to multiple breaks and cross-dependence. Ecological Economics 2008; 64(3): 559–74.

[42] Saboori, B, Sulaiman, J. CO_2 emissions, energy consumption and economic growth in Association of Southeast Asian Nations (ASEAN) countries: a cointegration approach. Energy 2013; 55: 813–22.

[43] Song, T, Zheng, T, Tong, L. An empirical test of the Environmental Kuznets Curve in China: a panel cointegration approach. China Economic Review 2008; 19(3): 381–92.

[44] Soytas, U, Sari, R, Ewing, BT. Energy consumption, income and carbon emissions in the United States. Ecological Economics 2007; 62(3–4): 482–9.

[45] Soytas, U, Sari, R. Energy consumption, economic growth, and carbon emissions: challenges faced by an EU candidate member. Ecological Economics 2009; 68(6): 1667–75.

[46] Stock, J, Watson, MW. A simple estimator of cointegrating vectors in higher order integrated systems. Econometrica 1993; 61(4): 783–820.

[47] Tang, CF, Tan BW. The impact of energy consumption, income and foreign direct investment on carbon dioxide emissions in Vietnam. Energy 2015; 79: 447–54.

[48] Tunc, GI, Turut–Asik, S, Akbostanci, E. CO_2 emissions vs. CO_2 responsibility: an input-output approach for the Turkish economy. Energy Policy 2007; 35(2): 855–68.

[49] Wang, Y, Zhang, X, Kubota, J, Zhu, X, Lu, G. A semi-parametric panel data analysis on the urbanization-carbon emissions nexus for OECD countries. Renewable and Sustainable Energy Reviews 2015; 48: 704–9.

[50] Yang, G, Sun, T, Wang, J, Li, X. Modeling the nexus between carbon dioxide emissions and economic growth? Energy Policy 2015; 86: 104–17.

[51] Zhang, X–P, Cheng, X–M. Energy consumption, carbon emission, and economic growth in China. Ecological Economics 2009; 68(3): 2706–12.

Table 1
Results of the Unit Root Test of Lee and Strazicich (2013)

Variables	LM	CV (1%)	CV (5%)	CV (10%)	Lag	Variables	LM	Lag	Break Date
Log Real GDP per Capita	–3.347	–4.239	–3.566	–3.211	0	Δ Log Real GDP per Capita	–6.280***	0	1979
Log Squared Real GDP per Capita	–3.323	–4.239	–3.566	–3.211	0	Δ Log Squared Real GDP per Capita	–6.264***	0	1979
Log CO_2 Emissions per Capita	–3.402	–4.239	–3.566	–3.211	0	Δ Log CO_2 Emissions per Capita	–6.218***	0	2000
Log Energy Consumption per Capita	–3.335	–4.239	–3.566	–3.211	0	Δ Log Energy Consumption per Capita	–6.624***	0	1976
Log Export Product Diversification	–2.077	–4.239	–3.566	–3.211	1	Δ Log Export Product Diversification	–5.168***	0	1976

Notes: The table shows the results of the unit root test of Lee and Strazicich (2013), and the results include break on the level. Null hypothesis: the series have unit root. The optimal number of lag is selected by the Akaike Information Criteria (AIC). The maximum number for lag is 3. Trimmer rate is defined as 0.10. CV: Critical Values. *** indicates the rejection of the null hypothesis at the 1% significance level.

Table 2
Results of the Cointegration Test of Maki (2012):
CO_2 Emissions – GDP per Capita – Squared GDP per Capita – Energy Consumption – Export Diversification

Cointegration among Variables	Test Statistics	CV (1%)	CV (5%)	CV (10%)	Break Dates
Model 1	–7.465***	–6.303	–5.839	–5.575	1984, 2000
Model 2	–8.764***	–6.556	–6.055	–5.805	1984, 1989
Model 3	–8.862***	–7.756	–7.244	–6.964	1984, 1990
Model 4	–8.629***	–8.167	–7.638	–7.381	1987, 1993

Notes: The table shows the results of the four models of the cointegration test of Maki (2012). The null hypothesis: there is no cointegration among the series, and the alternative hypothesis is cointegration with *i* breaks. The maximum number of breaks is 3. Trimmer rate is defined as 0.10. CV: Critical Values. Critical values are based on the bootstrapped values of Table 1 in Maki (2012). *** indicates the rejection of the null hypothesis at the 1% significance level.

Table 3

Results of the Dynamic Ordinary Least Squares (DOLS) Estimations for the Long-run Coefficients

Dependent Variable:	Log CO_2 Emissions per Capita
Log Real GDP per Capita	4.541 (1.523)***
Log Squared Real GDP per Capita	–0.553 (0.191)***
Log Energy Consumption per Capita	0.707 (0.179)***
Log Export Product Diversification	–0.032 (0.015)**
D1984	0.014 (0.008)
D2000	–0.007 (0.005)
Constant Term	–10.95 (2.708)***
Observations	37
Adjusted R^2	0.996
Leads and Lags	(1,1)
Standard Error of Regression	0.007
Durbin–Watson Statistics	2.177
Long-run Variance	0.409
Sum Squared Residuals (SSR)	0.001

Notes: Selection of break dates are based on the Model 1 of cointegration test of Maki (2012). The Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors (Bartlett kernel, Newey–West fixed bandwidth = 4.0000) are in parentheses. *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Table 4
Results of the Error Correction Model (ECM) Estimations for Short-run Coefficients

Dependent Variable:	ΔLog CO_2 Emissions per Capita
Error Correction Term (ECT)	–0.263 (0.129)**
ΔLagged Log CO_2 Emissions per Capita	0.252 (0.372)
ΔLagged Log Real GDP per Capita	14.46 (7.065)**
ΔLagged Log Squared Real GDP per Capita	–2.001 (0.951)**
ΔLagged Log Energy Consumption	0.113 (0.482)
ΔLagged Log Export Product Diversification	–0.033 (0.066)
Constant Term	0.009 (0.004)**
Observations	38
Adjusted R^2	0.036

Notes: The optimal number of lag length is selected by the Schwarz Information Criteria (SIC). The standard errors are in parentheses. ** indicates statistical significance at the 5% level.

Table 5

Results of the Granger Causality/Block Exogeneity Wald Tests

Dependent Variable:	ΔLog CO_2 Emissions	ΔLog GDP per Capita	ΔLog Squared GDP per Capita	ΔLog Energy Consumption	ΔLog Export Diversification	Overall Chi–square Statistics
ΔLog CO_2 Emissions:	–	7.272*** [0.0070]	7.664*** [0.0056]	0.012 [0.9112]	1.370 [0.2418]	11.90** [0.0180]
ΔLog GDP per Capita:	0.561 [0.4537]	–	1.330 [0.2488]	0.001 [0.9683]	0.039 [0.8416]	2.338 [0.6738]
ΔLog Squared GDP per Capita:	0.547 [0.4593]	1.173 [0.2787]	–	0.0005 [0.9807]	0.041 [0.8386]	2.270 [0.6861]
ΔLog Energy Consumption:	7.777*** [0.0053]	8.411*** [0.0037]	9.003*** [0.0027]	–	1.423 [0.2329]	21.04*** [0.0003]
ΔLog Export Diversification:	0.732 [0.3921]	0.049 [0.8244]	0.032 [0.8580]	0.637 [0.4245]	–	2.859 [0.5816]

Notes: The optimal number of lag length is selected by the Schwarz Information Criteria (SIC). The probability values are in brackets. *** and ** indicate the rejection of the null hypothesis at the 1% and 5% significance levels, respectively.

Appendix I
Descriptive Summary Statistics and the Description of Variables: 1971–2010

Variable	Unit	Data Source	Mean	Standard Deviation	Skewness	Kurtosis
Real per Capita GDP (constant $ price in 2005)	Logarithmic Form	World Bank, WDI	3.696	0.113	0.174	1.877
Squared Real per Capita GDP (constant $ price in 2005)	Logarithmic Form	World Bank, WDI	13.67	0.844	0.213	1.897
CO_2 Emissions (metric tons per capita)	Logarithmic Form	World Bank, WDI	0.401	0.138	–0.204	1.852
Energy Consumption (kilogram of oil equivalent per capita)	Logarithmic Form	World Bank, WDI	2.972	0.115	–0.070	1.936
Export Product Diversification (Theil index)	Logarithmic Form	International Monetary Fund	–1.075	0.214	0.772	2.276