Is export quality a viable option for sustainable development paths of Asian countries?

Manga, Muge and Cengiz, Orhan and Destek, Mehmet Akif

Erzincan Binali Yıldırım University, Çukurova University, Gaziantep University

29 September 2022

Is export quality a viable option for sustainable development paths of Asian countries?

Muge Manga[1] Orhan Cengiz[2] Mehmet Akif Destek[3]

ABSTRACT

This paper investigates the role of export quality in climate action goal of the sustainable development goals in emerging Asian countries. For this purpose, the empirical model that observes the impact of real GDP, energy use and export quality index on carbon emissions is constructed and is analyzed by ARDL bound test approach for the period from 1970 to 2014. We also include the square of real GDP as independent variable to observe the existency of Environmental Kuznets Curve (EKC) hypothesis which implies the parabolic relationship between economic growth and environmental degradation. The findings show that increase in export quality leads to a fall in CO_2 emissions for China and India. In contrast, the effect of increasing export quality increases CO_2 emissions in Thailand and the Philippines. Lastly, our asymmetric causality results show that the positive shocks of export quality causes positive shocks of CO_2 emissions in Thailand and Indonesia. Furthermore, we found that positive export quality shocks causes negative carbon emission shocks in India while negative export quality shocks causes positive carbon emissions shocks in China. We also confirm the inverted U-shaped EKC hypothesis in China and Thailand.

Keywords: EKC hypothesis; export quality; CO_2 emissions; emerging Asian countries; environmental degradation

[1] Faculty of Economics and Administrative Sciences, Department of Economics, Erzincan Binali Yıldırım University, Erzincan/Turkey, ORCID ID: 0000-0003-2675-2182. E-mail: mboga@erzincan.edu.tr
[2] Cukurova University Pozantı Vocational School, Department of Accounting and Taxation, Adana/Turkey, ORCID ID: 0000-0002-1883-4754. E-mail: ocengiz@cu.edu.tr
[3] Corresponding Author, Gaziantep University, Department of Economics, Gaziantep/Turkey, ORCID ID: 0000-0002-2514-9405, E-mail: adestek@gantep.edu.tr

1. Introduction

Despite developing countries have been growing dramatically for the last decades, they were exposed to paid large expenses due to the environmental degradation from the overuse of underground water, exceeding the capacity production of solid waste and industrial waste, degradation of the ecosystem, and also another troubles related nature (Diao et al., 2009). The relationship between economic growth and environmental degradation (generally using CO_2 emissions for measurement) is being taken a hand with EKC, termed inverted-U shaped. EKC's mechanism goes like that: in the first period of economic growth, countries generally focus on producing more output so that the level of material output increases and most people want employment. Thus, rapid growth in developing countries leads to more energy consumption, and it creates pressure on environmental pollution. Furthermore, when nations reach a threshold income level due to improving their industrial capacity, people become more focused on the environment to decrease pollution or CO_2 emissions (Sirag et al., 2018).

Three different dimensions comprise the EKC hypothesis. These are scale, composition, and technique effects. Grossman and Krueger (1991) asserted that the scale effect occurs when a country liberalizes trade and investment, which causes an expansion of economic activities to foster economic growth. This process exacerbates environmental degradation. The composition effect is the result of changing international trade policies. When countries abolish trade barriers, firms try to specialize in the sectors to obtain a competitive advantage. Suppose a competitive advantage arises from differences in environmental regulation standards. In that case, the effect of trade liberalization damages environmental quality. If governments do not regulate environment standards firmly, firms shift their focus to industries where environmental standards are weak. Finally, technique effects potentially contribute to a decreasing pollution level, especially in developing countries, due to the two reasons. First, in liberalizing trade and investment, modern production technologies lower environmental pollution and are transferred to these countries. Second, trade liberalization leads to a rise in people's income level, so the demand for a cleaner environment increases.

The link between income elasticity of environmental quality demand and the shape of the EKC is critical. As mentioned above, three dimensions factor into the direct structure of EKC. After the turning point, the demand for high living standards rises within an increase in income. This tendency encourages policymakers to understand and act on people's demand for environmental quality. This scheme is depicted as an inverted U-shaped EKC (Shahbaz and Sinha, 2019; Can and Gozgor, 2017).

The classical EKC approach focused on the impact of different factors on CO_2 emissions. However, in recent times some studies (Gozgor and Can, 2017; Mania, 2019; Shahbaz et al., 2019) explored the relationship between export quality and environmental pollution. Nowadays, we are witnessing the transformation of the world's economic structure. Within this change, the determination of new factors for energy demand becomes imperative. In this framework, export diversification/export quality and human capital have emphasized new determinants of energy demand in recent times (Shahbaz et al., 2019). As we know from international economics literature, developing countries do not have large exportable commodities basket. Generally, they export agricultural and labor intensity-based goods. These countries make an effort to expand export diversification to overcome this problem.

As one part of the growth strategy, export diversification requires gaining different goods from international trade. Countries must invest in strategic sectors that potentially add value, for example, energy, transportation, communication, finance, and industry, to achieve success with export diversification. Of course, this process concomitantly brings high-level energy demand, which is the leading CO_2 emissions source. Thus, most developing countries that want to achieve sustainable economic growth through export diversification must consider environmental pollution caused by high energy demand (Adewuyi and Awodumi, 2016). Gozgor and Can (2016) impressed the importance of export diversification on economic performance and environmental degradation that comes into the export basket of countries and causes rising CO_2 emissions during the export diversification of new commodities.

The most crucial point is that the export structure's transformation consists of two stages. At the first stage, less developed and developing countries continue to produce different types of exportable goods until they reach a high-income level. After the turning point, countries move to another stage called the "export concentration" step of export diversification. In this step, countries do not produce all types of goods. In other words, they start to produce technology intensive commodities rather than traditional ones. Since countries change their product structure composition, including more technology, environmental degradation starts to fall (Can and Gozgor, 2017; Apergis et al., 2018; Fang et al., 2019). As we mentioned before, technological effects occur later in the stage of economic development. As international trade expands, countries produce more efficiently, leading to transforming production bases, positively affecting environmental quality via technological improvement (Gozgor, 2017; Fang et al., 2019).

In light of the above discussions, this paper aims to investigate the impact of export quality on CO_2 emissions in emerging Asian countries over the period from 1970 to 2014. There are two reasons for the selection of this country group. First of all, the economic growth of these countries mainly

depends on export. Secondly, these countries are responsible for a high level of carbon emissions. So the export structure becomes a critical issue for environmental degradation in emerging Asian countries. The contributions of this study to the existing literature by twofold: i) This study is the first to examine the relationship between export quality and CO2 emissions for emerging Asian countries to best our knowledge; ii) We employ ARDL bounds testing and asymmetric causality methodologies to explore the linkage between export quality and CO_2 emissions for the country-specific findings.

Our results suggest the existence of robust evidence that export quality is negatively associated with CO2 emissions in China, Indonesia, and Oman; in contrast, it is positively related to CO2 emissions in Thailand and the Philippines. The organization of the rest of the paper is as follows. Section 2 briefly tries to explain the critical role of export in emerging industrialized Asian countries. Section 3 exhibits empirical literature related to the EKC hypothesis. Data, model, and methodology are specified in Section 4. Section 5 shows our empirical results, and Section 6 offers conclusions and policy recommendations.

2. Export Quality and Environment Nexus

In the past decades, export diversity has become one of the most essential components of economic growth. So scholars focused on this phenomenon. Export diversification affects economic growth through two different channels. First of all, it is associated with the financial sector and is called the portfolio effect. In this approach, a high level of export diversification means lower fluctuation of gains from export. Lower volatility can be evaluated in positive and negative perspectives. On the positive side, while countries do not have enough mobility capacity for reaching world financial markets, they do not have to flatten consumption in case of large volatility in exports and output. However, less volatility of growth can be caused by hysteresis. If it causes hysteresis, it means countries' exports are highly sensitive to exchange-rate volatility. Second, long-run economic growth is related to expanding goods in the export basket. This view originates from the joining of new commodities to the production range (Agosin, 2009).

In the 21st century, emerging Asian countries are becoming progressively interdependent. In recent times, the rise of emerging Asian economies is transforming the global economy's available balance. Both sustainable growth and integration into the regional and world economy are the main driving force in emerging Asian markets. These forces of the emerging Asian economies places them in a vital position in the global economy. Because of these reasons, the Asian region has become a fundamental manufacturer and exporter of many goods (Kim et al., 2011). Undoubtedly, the most prominent role of this emerging trend belongs to China.

4

However, many studies try to investigate the impact of export diversification on economic growth (Al-Marhubi, 2000; Hesse, 2008; Arip et al., 2010; Agosin et al., 2012; Cadot et al., 2011; Mudenda et al., 2014; Hamed et al., 2014; Henn et al., 2015). However, export diversification requires a high level of energy use. A high level of energy use creates a significant increase in CO_2 emissions. According to the International Energy Agency (IEA 2019) report, total CO_2 emissions rose by 60.03% from 1990 to 2019, while CO_2 emissions per capita increased 12,63% in the same period. Considering the general view of Asian economies' CO_2 emissions, it reveals remarkable results that without China, CO_2 emissions per capita of Asian countries increased from 0,75 tons to 1,7 tons over 1990 and 2017. In China, CO_2 emissions per capita increased from 1,8 tons to 6,7 tons in the same period. In China, CO_2 emissions per capita level is above the world average (world average was 3,90 tons in 1990 and 4,4 tons in 2017). Furthermore, The Global Commission for Urgent Action on Energy Efficiency, which was established on June 24, 2019, pointed out that global energy demand goes on increasing, and also CO_2 emissions reached a record level. Moreover, energy intensity does not grow rapidly enough to offset energy demand and CO_2 emissions growth levels (IEA, 2019).

<Insert Figure 1 here>

Therefore, this situation reveals the importance of export quality on the environment, especially in developing countries. Figure 1 represents the export quality index and CO_2 emissions per capita for selected emerging Asian markets. As we see, the export quality index and CO_2 emissions per capita have a significant upward trend in countries economies over the period from 1970-2014. Starting from this point of view, some studies investigate the relationship between export quality and environmental degradation that have recently become prominent (Gozgor and Can, 2016; Gozgor and Can, 2017; Mania, 2019; Fang et al., 2019; Shahbaz et al., 2019).

3. Empirical Literature Review

There is a growing literature for testing EKC for the last three decades. Firstly, Grossman and Krueger (1991) revealed the relationship between economic growth and environmental degradation that economic growth causes the environmental degradation at the initial stage, and after the threshold level, environmental degradation starts to decline. This relationship means that there is an inverted-U shaped linkage between economic growth and environmental degradation. Related literature examined the validity of the EKC hypothesis, and they used different econometrics methods, models, countries (or regions), and focused on the different data periods. Thus, the literature can also be divided based on different aspects.

The first classical or earlier approach investigates the economic growth-environmental degradation (or CO_2 emissions) relationship, and it tries to provide some findings for the validity of the EKC hypothesis. For instance, Apergis and Ozturk (2015) examined the validity of the EKC hypothesis for 14 Asian countries spanning 1990-2011 using the GMM estimator. Their findings provided support for the EKC hypothesis. Halkos (2011) examined the determinants of an EKC for 1971-2006 using the different econometric methods to estimate the economic growth-environmental degradation. The results varied by different regions and countries. Namely, their research revealed a monotonic, inverted U-shape, or N-shape relationship between income level and environmental pollution. Narayan and Narayan (2010) used 43 developing countries' data to examine the existence of EKC based on short and long-run elasticities of income over the period 1980-2004. Using the different kinds of panel methodologies such as the panel cointegration and the panel long-run estimation techniques, they concluded that the long run's income elasticity is smaller than the short-run just for Middle Eastern and South Asian countries. It means that the EKC hypothesis is only valid in these country groups.

Another aspect employs a multivariate framework to analyze the EKC hypothesis, including the role of energy consumption. This approach aims to examine the linkage between economic growth, energy consumption, and CO_2 emissions. For example, Pao and Tsai (2010) examined the relationship in CO_2 emissions, GDP, GDP square, and energy consumption in BRIC countries for the period 1971-2005. Their results showed that there is an inverted-U shaped relationship between CO_2 emissions and income. Also, energy consumption has a positive impact on CO_2 emissions. Apergis and Payne (2010) provided similar results for the Commonwealth of Independent States. They probed the relationship in CO_2 emissions, GDP, GDP square, and energy consumption for the 1992-2004 period. Also, there was a one-way causality running from consumption and GDP to CO_2 emissions in the short run. Meanwhile, there was a two-way causality between energy consumption and GDP. In the long-run, there is a feedback causality between energy consumption and CO_2 emissions. In contrast, Mikayilov et al., (2018) employed Azerbaijan's data to investigate the linkage between CO_2 emissions, GDP, GDP square, and energy consumption from 1992 to 2013 using cointegration analysis. With getting robust results Johansen, ARDL (Auto-Regressive Distributed Lag), DOLS (Dynamic Ordinary Least Squares), FMOLS (Fully Modified Ordinary Least Squares), and CCR (Canonical Cointegration Regression) methods. They found that the EKC hypothesis does not exist in Azerbaijan. Ozcan (2013) utilized Middle East countries' data to examine the relationship in CO_2 emissions, GDP, GDP square, and energy consumption for the period 1990-2008. The results provided evidence that there was a U-shaped relationship between variables in 5 countries, while there was an inverted-U shaped EKC in 3 countries. The analysis Le

and Quah (2018) tried to explore the relationship between CO_2 emissions, energy consumption, GDP, and GDP square for 14 selected countries in Asia and the Pacific from 1984-2012. Their empirical findings using the Fully Modified OLS estimators' results implied that the EKC hypothesis was not valid in lower and upper-middle-income countries. However, findings from high- income countries support the validity of the EKC hypothesis. Saboori and Sulaiman (2013) examined the link between CO_2 emissions, GDP, GDP square, and energy consumption such as coal, gas, electricity, and oil from 1980 to 2009 in Malaysia. Their empirical results did not confirm the existence of the EKC hypothesis when total energy consumption data is taken into consideration. However, their results supported the EKC hypothesis when individual energy consumption data is used. Furthermore, Granger causality test results stated that there was a feedback nexus between GDP and CO_2 emissions, and within energy consumption. Alam et al. (2016) employed the data of Brazil, China, India, and Indonesia to explore whether EKC is valid, using the data CO_2 emissions GDP, GDP square, energy consumption, and population spanning the period 1970 and 2012. Empirical observations state that CO_2 emissions decrease when economic growth rises in Brazil, China, and Indonesia. Nevertheless, as income increases, CO_2 emissions rise as well in India.

The third strand consists of studies analyzing the EKC hypothesis, including the role of globalization (trade and financial development). Jalil and Mahmud (2009) used data from China to test the presence of any relationship between CO_2 emissions, GDP, GDP square, energy consumption, and trade openness over the period 1975 and 2005. Using the ARDL bounds testing and Granger causality test, it was concluded that the relationship between economic growth and CO_2 emissions exhibited an inverted U-shaped curve. It is also founded that economic growth and energy consumption are the main determinants of CO_2 emissions, but trade has not meaningful any impact on CO_2 emissions. Ozturk and Acaravci (2013) investigate the relationship between CO_2 emissions, GDP, GDP square, energy consumption, trade openness, and financial development in Turkey for 1960-2007. The empirical findings support the validity of the EKC hypothesis, and trade openness leads to an increase in CO_2 emissions, while financial development has no impact on CO_2 emissions. Ahmed and Long (2013) explore the relation between CO_2 emissions, GDP, GDP square, energy consumption, trade openness, population growth using the ARDL bounds testing approach over time-series data from the period 1971 to 2008 in Pakistan. They approved the inverted U-shaped relationship between economic growth and CO_2 emissions in the long-run, but there is a U-shaped linkage between those variables in the short-run. Additionally, trade openness only improves the environment in the short-run. Atici (2012) examined the relationship between trade liberalization and FDI on CO2 emissions, GDP, GDP

7

square, GDP cube in ASEAN countries, and Japan for 1970 and 2006. The author's results indicate that the relationship between economic growth and CO_2 emissions follows an S-shaped trajectory. The author also found that export causes CO_2 emissions while there is not taken any evidence that FDI does not have any impact on CO_2 emissions in Indonesia, Malaysia, Thailand, and the Philippines. Haseeb et al. (2018) examine the impact of energy consumption, financial development, globalization, economic growth, and urbanization on CO_2 emissions in the presence of EKC for the panel data of BRICS countries from 1995 to 2014. They provided the evidence to support the validity of the EKC hypothesis. Furthermore, it is revealed that energy consumption and financial development negatively impact CO_2 emissions levels, while globalization and urbanization have a negative but insignificant linkage with CO_2 emissions. Dumitrescu-Hurlin Granger causality test results show a two-way causality relationship between energy consumption, financial development, GDP, and GDP square with CO_2 emissions, while unidirectional causality runs from globalization and urbanization to CO_2 emissions.

Onafowora and Owoye (2014) used data from Brazil, China, Egypt, Japan, Mexico, Nigeria, South Korea, and South Africa to probe relationship CO_2 emissions, GDP, GDP square, energy consumption, population density, and trade openness, analysis period that covered the time from 1970 to 2010. The findings showed that economic growth and CO_2 emissions formed an N-shaped trajectory in Brazil, China, Egypt, Mexico, Nigeria, and South Africa, whereas there exists an inverted U-shaped EKC hypothesis in Japan and South Korea. Findings of trade openness and population density are mixed. Shahbaz et al. (2015a) investigated the relationship in CO_2 emissions, GDP, GDP square, financial development, and globalization using annual data from 1970-2012 in India. Their empirical outcomes validate the holding of the EKC hypothesis in India. Further, both energy consumption and financial development, and globalization are positively associated with CO_2 emissions. Allard et al. (2018) tested whether N-shaped EKC exists, using the CO_2 emissions, GDP and GDP square, renewable energy consumption, technological development, trade, and institutional quality variables for 74 countries from 1994 to 2012. The authors found some evidence that N-shaped EKC exists in lower-middle-income, high-income countries, and the total sample, there is no significant relationship for upper-middle-income. According to their results, trade is positively related to CO_2 emissions. Farooq et al. (2022) explored the impact of globalization on CO_2 emissions for 180 countries over the period 1980-2016 using the EKC framework. The findings provide that the EKC hypothesis is valid, and while economic globalization escalates CO_2 emissions, political globalization helps reduce CO_2 emissions.

However, recent studies have examined the nexus between export quality and CO_2 emissions. There are only a few studies about environmental degradation in the context of export

diversification/concentration and quality. So it is possible to sort studies that are associated with export diversification/quality and environmental degradation. Gozgor and Can (2016) revealed that the EKC hypothesis is consistent in Turkey during the period 1971-2010 for the short and long run. Also, when export diversification enlarges, CO_2 emissions increase as well in the long term. In a similar paper, Gozgor and Can (2017) investigated EKC and the role of export quality on CO_2 emissions in China for the period from 1971 to 2010. As a result, EKC is valid in China, and also both energy consumption and trade openness positively impact CO_2 emissions while export quality negatively impacts CO_2 emissions. Mania (2019) obtained by using system GMM and PMG methods, as well as EKC, exists, export diversification is positively associated with CO_2 emissions in 98 developed and developing countries over the period 1995-2013. The same study conducted by Fang et al. (2019) exhibits that export quality, income per capita, and trade openness positively impact CO_2 emissions, consisting of 82 developing countries over the period 1970-2014. Using various variables, Shahbaz et al. (2019) tested the relationship between education, export diversification, natural resource, oil prices, income, and energy demand for the USA spanning the period 1975-2016. Their results illustrated that in the long term, export diversification leads to a reduction in energy demand. On the contrary, education negatively impacted energy demand. Furthermore, export diversification, oil prices, and natural resource production decrease energy demand, while economic growth causes energy demand. Apergis et al. (2018) aimed to investigate the impacts of export concentration on CO_2 emissions in 19 developed countries between 1962 and 2010. They found that the EKC hypothesis existed in these economies, and the rising level of export concentration supported a reduction in CO_2 emissions.

<Insert Table 1 here>

Table 1 shows that there were limits to the research on export quality impacts on environmental degradation. This study utilized annual data to fill this gap, examining the relationship between export quality and CO_2 emissions, taking 1970-2014 for the seven selected emerging Asian countries.

9

In the light of previous studies, our goal is to contribute to the literature through testing the EKC hypothesis and the impact of export quality on CO_2 emissions by using panel ARDL and asymmetric causality method for selected emerging Asian economies using data spanning the period 1970-2014.

4. DATA AND METHODOLOGY

4. 1. Empirical Model and Data

This study aims to test the relationship between the export quality and environmental degradation in the context of the Environmental Kuznets Curve (EKC) hypothesis. The period coverage for all series was 1970-2014 for seven emerging Asian countries (China, Thailand, Philippines, Indonesia, India, South Korea, Oman). The export quality index (EXPQ) represented the general quality of goods and services exporting to another country. The Standard International Trade Classification (SITC), which consisted of 800 different bundles, was exploited for export quality index calculation. Export quality index indicators for each country were obtained from the IMF database.

Carbon emission (metric tons per capita) was used as an indicator of environmental degradation, and GDP per capita (at the constant price of 2010 US dollars) was used to represent economic growth. Also, energy use (kg of oil equivalent per capita) was added to the model as a control variable. All these series were retrieved from the World Bank Development Indicator.

Our goal is to determine the impact of export quality on CO_2 emissions in the context of EKC hypothesis. Following the studies of Gozgor and Can (2017), Fang et al. (2019) and in line with our purpose, from EKC theory, an empirical model was written as follows:

$$(CO_{2t}) = f(GDP_t, GDP_t^2, Euse_t, EXPO_t) \quad (1)$$

The empirical model in Eq. (1) can be written with logarithmic form as follows:

$$Ln(CO_{2t}) = \beta_0 + \beta_1 LnGDP_t + \beta_2 LnGDP_t^2 + \beta_3 LnEuse_t + \beta_4 LnEXPQ_t + \varepsilon_t \quad (2)$$

In Eq. (2), dependent variable CO_2 refers to carbon dioxide emissions per capita, GDP_t represents real income per capita, GDP_t^2 represents the square of real GDP per capita, Euse is energy use per capita EXPQ means export quality index.

Depending on the sign of the different β parameters related to income, the EKC will have different shapes (Dinda, 2004):

i) If $\beta_1 = \beta_2 = 0$, there is not any relationship between CO_2 and GDP.

ii) If $\beta_1 > 0$ and $\beta_2 = 0$ shows a monotonic or linear increasing relationship, it means that CO_2 rises along with GDP.

10

iii) $\beta_1 < 0$ and $\beta_2 = 0$, there exists a monotonic or linear decreasing linkage between CO_2 and GDP.

iv) $\beta_1 > 0$ ve $\beta_2 < 0$ illustrates an inverted-U-shaped relationship between CO_2 and GDP that the EKC hypothesis is valid.

v) $\beta_1 < 0$ ve $\beta_2 > 0$ depicts a U-shaped relationship between CO_2 and GDP. Additionally, $the\ \beta_3$ coefficient measures impact of Euse on CO_2 and β_4 shows the impact of export quality on CO_2, respectively.

We used cointegration and causality tests to investigate the relationships between environmental degradation and export quality for selected emerging Asian countries. We also used the ARDL (Autoregressive Distributed Lag) model of Pesaran et al. (2001) to apply a cointegration test to point out short and long-run relationships between the variables for Eq. (1). We chose this method because the ARDL method has several advantages over Engle and Granger (1987); Johansen and Juselius' (1990) cointegration tests due to the different cointegration levels [I(0), (1)] (Iwata et al., 2010).

The ARDL method's equation is modeled as Eq. (3)

$$\Delta(CO_2)_{it}=\alpha_i + \sum_{i=1}^{n} \beta_{0i}\Delta LnCO_{2_{it-i}} + \sum_{i=0}^{n} \beta_{1i}\,\Delta LnGDP_{t-i} + \sum_{i=0}^{n} \beta_{2i}\Delta LnGDP_{t-i}^2 + \sum_{i=0}^{n} \beta_{3i}\Delta LnEuse_{i-j} + \sum_{i=0}^{n} \beta_{4i}\Delta LnEXPQ_{i-j} + \beta_i' LnCO_{2_{t-1}} + \delta_i' LnGDP_{t-1} + \varphi_i' LnGDP_{t-1}^2 + \gamma_i' LnEuse_{t-1} + \emptyset_i' LnEXPQ_{t-1} + \varepsilon_{it} \quad (3)$$

In the model, in for $\beta_i' = \delta_i' = \varphi_i' = \gamma_i' = \emptyset_i' = 0$, there was no relationship between variables (the null hypothesis), while $\beta_i' \neq \delta_i' \neq \varphi_i' \neq \gamma_i' \neq \emptyset_i' \neq 0$ indicated there were long-termed relationships between variables (the alternative hypothesis).

Moreover, ε_{it} is the error term in Eq. (3). In case of variables are cointegrated, we can specify both short and long-run ARDL equations as follows respectively:

$$CO_{2t} = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\Delta CO_{2t-i} + \sum_{i=1}^{q} \beta_{2i}\Delta GDP_{t-i} + \sum_{i=1}^{r} \beta_{3i}\Delta GDP_{t-i}^2 + \sum_{i=1}^{s} \beta_{4i}\Delta Euse_{t-i} + \sum_{i=1}^{k} \beta_{5i}\Delta EXPQ_{t-i} + \epsilon_t \quad (4)$$

$$CO_{2t} = \delta_0 + \sum_{i=1}^{p} \delta_{1i}\Delta CO_{2t-i} + \sum_{i=1}^{q} \delta_{2i}\Delta GDP_{t-i} + \sum_{i=1}^{r} \delta_{3i}\Delta GDP_{t-i}^2 + \sum_{i=1}^{s} \delta_{4i}\Delta Euse_{t-i} + \sum_{i=1}^{k} \delta_{5i}\Delta EXPQ_{t-i} + \lambda ECM_{t-1} + \tau_t \quad (5)$$

Where λ represents the coefficient of error correction term, we also used, such as autocorrelation, heteroscedasticity, and normality tests to control the significance of the model and check the stability of the long-term parameters.

5. Empirical Findings

11

In the ARDL bounds testing, the proper ARDL model and F statistics should be determined for each specified country group. On this basis, Table 2 presents the proper ARDL model and F statistics for each selected country group. The results of the ARDL bounds test indicate that the F statistics values exceed the upper threshold level established by Pesaran, Shin, and Smith (2001) at the 1 percent significance level for China, Thailand, Indonesia, and Oman, and at the 10 percent significance level for Philippines, India, and South Korea. Therefore, we rejected the null hypothesis of no cointegration, and this finding indicated a long-term cointegration between variables. In next step, before observing the impacts of independent variables, we should check the diagnostic tests such as the ARCH test has been accounted for the heteroscedasticity problem, and the Breusch-Godfrey LM test identified autocorrelation in the model. Furthermore, the Ramsey test was used to check the functional form's accuracy in the selected models. The CUSUM and CUSUMQ tests implied the consistency of the model's residual variance in the ARDL bounds testing and estimated long-term parameters. When we look at the diagnostic tests results from Table 3, Diagnostic test results showed that the selected model forms for each selected country are correct, and autocorrelation and heteroscedasticity do not exist in a given model.

<Insert Table 2 here>

In the next stage, the short and long-run coefficients of ARDL can be seen in Table 3. First of all, it is indicated that the EKC hypothesis is valid in the long term for China and Thailand. The results were consistent with the findings from Jalil and Mahmud (2009), Yin et al. (2015), and Shahbaz et al. (2015b) for a sample from China, and Paweenawat and Plyngam (2017) for Thailand. On the contrary, findings for Indonesia, India, and South Korea conclude that we obtained a U-shaped relationship between CO_2 emissions and economic growth both in the short and long run. It means the EKC hypothesis was not supported in these countries. We compared the result of Indonesia with the findings of Saboori et al. (2012). They found a U-shaped EKC for Indonesia, as in our study. Additionally, Sugiawan and Managi (2016) have offered an inverted-U shaped EKC in Indonesia that contrasts ours. Furthermore, the outcomes for India can be compared with some studies in the literature. For example Usman et al. (2019), Solarin et al. (2017), Ozturk (2015), and Rana and Sharma (2019) have reached the different findings from ours in India. The reason for this unexpected result was potentially explained as follows. In an emerging economy like India, energy consumption is the primary driver of economic growth, particularly non-renewable energy sources. In these countries, primary or non-renewable energy consumption causes high-level CO_2

emissions. India has been feeling the disadvantages of lack of energy sources for a long time, and inequality in energy intensity can be seen among India's provinces. Moreover, India's social conditions, especially the population, improved environmental degradation, because social development demand causes them to consume more energy. Thanks to a lack of eco-friendly energy structure, India was forced to use fossil fuels that contributed to increases in CO_2 emissions (Sinha, 2015). Similarly, in South Korea, while Zhang (2018) found the results in the opposite direction of our study, Koc and Bulus (2020)' findings are consistent with our study. Obtaining the evidence contrary to the EKC hypothesis for South Korea can be explained in the context of different points. Firstly, South Korea is one of the 15 largest economies in the world, but at the same time, it is one of the most pollutant ten countries in terms of CO_2 emissions. These two aspects show us that economic growth does not improve environmental quality. In other words, economic achievement does not lead to environmental recovery. On the contrary, it makes it worse. Also, when we investigate the distribution of Korea's energy consumption, it gives us important clues. For instance, renewable energy has just only a 2% share, whereas oil has a share of 43%, coal 29%, natural gas 16%, and nuclear energy 10% in sources of primary energy supply (Koc and Bulus 2020). Besides, the EKC hypothesis is valid just in the short run for Oman. It is possible to encounter mixed results in terms of the validity of the EKC hypothesis. Arouri et al. (2012) found as their sample of countries that there was an inverted U-shaped relationship between economic growth and CO_2 emissions. In contrast to this study, Ozcan (2013) provided evidence of a U-shaped non-linear linkage between economic growth and CO_2 emissions. Like Oman, oil exporter countries can achieve high-level economic growth due to their oil reserves and exports. However, in these countries, the economic structure is based on the primary sector, and transformation to the service sector occurs very slowly. So economic growth was achieved at the expense of environmental degradation. Changing the economic structure gradually improves environmental quality (Arouri et al., 2012; Ozcan, 2013).

<Insert Table 3 here>

Additionally, according to Table 3, the short and long-run effect of energy use on CO_2 emissions is positive, as expected for all countries. As we know, energy use is an inseparable part of economic activities. These findings are consistent with Arouri et al. (2012), Chen and Huang (2013), Ahmed et al. (2016), Usman et al. (2019), Koc and Bulus (2020).

13

The estimates further show that the export quality negatively influences CO_2 emissions in China and India. This empirical finding on the impact of export quality on CO_2 emissions is in line with the previous empirical results of studies on several different country groups (e. g., Gozgor and Can 2017; Apergis et al., 2018, Shahbaz et al., 2019). The encouragement of the firms to produce of high-quality products that do not cause environmental pollution and the use of advanced technology in the exported goods are the main explanations of the negative relationship between two variables in these countries. On the other hand, the rise in export quality has a positive impact on CO_2 emissions in Thailand and the Philippines. The findings are consistent with the results of Gozgor and Can (2016) for Turkey, Mania (2019) for 98 developed and developing countries, Fang et al. (2019) for 82 developing countries. As long as emerging countries continue to realize the economic growth through upgrading the quality of their export basket, this brings out pressure to increase CO_2 emissions. Because diversifying the export basket is required a high level of energy use in macroeconomic activity. Increasing energy use in the macroeconomic activity may cause to rise in environmental degradation (Gozgor and Can, 2016). Furthermore, emerging economies have weak pollution regulation. Firstly, policymakers should empower regulatory standards. Secondly, export quality can be improved by export diversification. Thirdly, increasing the level of physical investments, including building railways and highways, level of human capital investments, and foreign direct investments, can support the upgrading export quality (Fang et al., 2019; Mania, 2019; Can and Gozgor, 2017).

Additionally, we employ the asymmetric causality test developed by Hatemi-J (2012) to ascertain the consistency of the study's conclusions. We do so by examining the validity of causal links between export quality and carbon emissions, which is consistent with the study's primary objective. Because the application of this test enables us to evaluate the causal linkages between positive and negative shocks among the variables under consideration, it is also intended to acquire more thorough conclusions.

The findings of the asymmetric causality test are shown in Table 4. When the findings are analyzed, it is clear that the causality from positive shocks of export quality to positive shocks to carbon emissions holds true for Thailand and Indonesia. When compared to the ARDL coefficient estimates, we conclude that the observation that an increase in export quality results in increased environmental deterioration is unquestionably applicable for Thailand. On the other hand, causality from positive shocks of export quality to negative shocks of carbon emissions is found to be valid exclusively for India. Surprisingly, while there is no causal association between positive export quality shocks and positive carbon emissions shocks in China, there is a causal relation from negative export quality shocks to positive carbon emissions shocks. These two findings do not

contradict the ARDL coefficient estimation results, which indicate that an increase in export quality reduces carbon emissions for both countries, but provide further detail. According to these data, improving India's export quality still results in a reduction in carbon emissions. On the other hand, while improving China's export quality does not result in a reduction in carbon emissions, declining export quality has a detrimental effect on the environment. This indicates that China has reached the pinnacle of export quality.

<Insert Table 4 here>

When the findings are summed, it is stated that Thailand, the Philippines, and Indonesia are in the export diversification stage, which may be viewed as a precursor to export quality improvement; hence, increasing export quality increases carbon emissions. While diversification of exports is a priority for these countries, the export of technology-intensive commodities and the need to produce eco-friendly products are relegated to the background. On the other hand, it is apparent that India has mostly completed the export diversification phase and has begun to place a premium on export quality, which contributes to environmental quality. China is found to be more advanced than India in terms of export quality, having reached an optimum level of export quality.

6. Concluding Remark

It is well-known that less developed countries usually strive to compete in the global economy via exporting their agricultural-based and labor-intensive commodities in the early development stage. To reach a high-level income with this road brought the new discussion to energy economic literature that countries' quality of exported goods plays a crucial role in environmental degradation (mostly CO_2 emissions). There were few analyses about export quality and CO_2 emissions (Gozgor and Can, 2017; Fang et al., 2019). So we try to contribute to the related literature in this framework. For this purpose, our paper examines the dynamic relationship among CO_2 emissions, export quality, energy use, and GDP per capita income in selected seven emerging Asian countries (China, Thailand, Philippines, Indonesia, India, South Korea, and Oman) over the period 1970-2014. We use two methods-ARDL and asymmetric causality. At the first stage, we apply a cointegration test to reveal the relationship among variables using ARDL bounds testing. In the second stage, we added robustness checks to confirm our results. For that purpose, an asymmetric causality test developed by Hatemi-J was used to analyze the causality relationship between export quality and CO_2 emissions.

When the empirical findings are linked to the EKC hypothesis, it is clear that the inverted U-shaped relationship is valid in the long run for China and Thailand. Additionally, the validity of the EKC hypothesis is validated in the short run for China and Oman. In Indonesia, India, and South Korea, on the other hand, there is a U-shaped relationship between economic growth and CO2 emissions. On the other side, a boost in export quality benefits China and India while harming Thailand and the Philippines.Meanwhile, asymmetric causality findings show that a positive shock in export quality caused an increase in CO_2 emissions in Thailand and Indonesia, while in India, a positive shock in export quality caused a reduction in CO_2 emissions. In addition, it is surprisingly validated that negative shocks of export quality causes positive shocks of carbon emissions in China.

In regards to policy implications, we concluded that global warming is an important phenomenon to consider (Tan et al., 2022). Empirical findings showed that, as countries continue to export whatever they produce, the environmental quality will be affected negatively. Thus, when countries try to expand their exportable goods from the primary sector to more high technology sectors, increased export quality and environmental quality of the globe will rise. However, we must always keep in mind that for developing countries, it is not so easy to change the production structure in the short run. The importance of global coordination must become a part of economic activity. Our last recommendation was that states should provide universal norms, rules, and standards for global warming, and more importantly, decision-makers should strengthen universal binding rules. Based on this study's results, the following policy implications are suggested: (i) Energy use is the primary driver of increasing CO_2 emissions. It is vital to utilize critical policies to use new technological methods that provide energy efficiency or to evolve the consumption habits of society towards energy efficiency (Mirza et al., 2022; Khan et al., 2022). (ii) Additionally, the role of technology intensity in the production process is an essential determinant of export quality. In China and India considering the negative impact of export quality on CO_2 emissions, it should be said that these countries expand their technological capacity, and also governments should encourage sustainable growth to tackle CO_2 emissions. (iii) A suitable environmental policy to reduce CO_2 emissions without harming economic growth is required to establish comprehensive energy infrastructure and avoid energy wastage in emerging Asian countries.

One of the limitations of this study was that the analysis was based on the relationship between the EKC hypothesis and export quality. Simultaneously, all emerging Asian countries' roles in global energy consumption are considerable due to the lack of data availability. We did not investigate the sectoral impact of export quality on CO_2 emissions. Future research would consider this aspect to test the validity of the EKC hypothesis for different countries. It should also be focused on

16

comparing the impact of renewable and non-renewable energy consumption in the export sector on CO_2 emissions in different countries.

Author contributions: Müge Manga: Data Curation, Resources, Methodology, Investigation, Formal analysis, **Orhan Cengiz:** Data Curation, Resources, Writing Original Draft, **Mehmet Akif Destek:** Writing Original Draft, Review & Editing.

Data availability: The datasets will be provided, if required

Declarations

Ethics approval: Not applicable

Consent to participate: Not applicable

Consent for publication: Not applicable

Conflict of interest: The authors declare no competing interests

Funding: None

References

Abbasi F, Riaz K. 2016. CO_2 emissions and financial development in an emerging economy: an Augmented VAR approach. *Energy Policy* **90**: 102-114. http://dx.doi.org/10.1016/j.enpol.2015.12.017

Adewuyi AO, Awodumi OB. 2016. Analysis of the environmental pollution effect of Nigeria's export diversification drive. Paper presented at the Annual Conference of the Nigerian Economic Society, Abuja, Nigeria.

Adom PK, Amakye K, Barnor C, Quartey M. 2015. The long-run impact of idiosyncratic and common shocks on industry output in Ghana. *OPEC Energy Review* **39** (1): 17-52.

Agosin MR. 2009. Export diversification and growth in emerging economies. *Cepal Review* **97**: 115-131.

Agosin MR, Alvarez R, Bravo-Ortega C. 2012. Determinants of export diversification Around the world: 1962-2000. *The World Economy* **35** (3): 295-315.

Ahmad M, Zahoor A, Yang X, Hussain N, Sinha A. 2021. Financial development and environmental degradation: Do human capital and institutional quality make a difference?, *Gondwana Research*. https://doi.org/10.1016/j.gr.2021.09.012

553 Ahmad N, Du L, Lu J, Wang J, Li HZ, Hashmi MZ. 2017. Modelling the CO_2 emissions and
554 economic growth in Croatia: is there any environmental Kuznets curve?. *Energy* **123**: 164-
555 172. http://dx.doi.org/10.1016/j.energy.2016.12.106
556 Ahmed K, Long W. 2013. An empirical analysis of CO_2 emission in Pakistan using EKC
557 hypothesis. *Journal of International Trade Law and Policy* **12** (2): 188-200. DOI 10.1108/JITLP-
558 10-2012-0015
559 Ahmed K, Shahbaz M, Kyophilavong P. 2016. Revisiting the emissions-energy-trade nexus:
560 Evidence from the Newly industrializing countries. *Environmental Science and Pollution*
561 *Research* **23** (8): 7676-7691. DOI 10.1007/s11356-015-6018-x
562 Alam MM, Wahid MM, Hanifa A, Noman M, Ozturk I. 2016. Relationships among carbon
563 emissions, economic growth, energy consumption and population growth: Testing
564 environmental Kuznets curve hypothesis for Brazil, China, India and Indonesia. *Ecological*
565 *Indicators* **70**: 477-479.
566 Allard A, Takman J, Uddin GS, Ahmed A. 2018. The N-shaped environmental Kuznets curve: An
567 empirical evaluation using a panel quantile regression approach. *Environmental Science and*
568 *Pollution Research* **25** (6): 5848-5861. https://doi.org/10.1007/s11356-017-0907-0
569 Al-Marhubi F. 2000. Export diversification and growth: an empirical investigation. *Applied*
570 *Economics Letters* **7** (9): 559-562. DOI: 10.1080/13504850050059005
571 Al-Mulali U, Ozturk I, Solarin SA. 2016. Investigating the environmental Kuznets curve hypothesis
572 in seven regions: The role of renewable energy. *Ecological Indicators* **67**: 267-282.
573 http://dx.doi.org/10.1016/j.ecolind.2016.02.059
574 Al-Mulali U, Tang CF, Ozturk I. 2015. Estimating the environment Kuznets curve hypothesis:
575 Evidence from Latin America and the Caribbean Countries. *Renewable and Sustainable Energy*
576 *Reviews* **50**: 918-924. http://dx.doi.org/10.1016/j.rser.2015.05.017
577 Apergis N, Can M, Gozgor G, Lau CKM. 2018. Effects of Export concentration on CO_2 emissions
578 in developed countries: an empirical analysis. *Environmental Science and Pollution Research* **25**
579 (14): 14106-14116. https://doi.org/10.1007/s11356-018-1634-x
580 Apergis N, Ozturk I. 2015. Testing environmental Kuznets curve hypothesis in Asian
581 countries. *Ecological Indicators* **52**: 16-22. http://dx.doi.org/10.1016/j.ecolind.2014.11.026
582 Apergis N, Payne JE. 2010. The emissions, energy consumption, and growth nexus: Evidence from
583 the commonwealth of independent states. *Energy Policy* **38** (1): 650-655.
584 doi:10.1016/j.enpol.2009.08.029
585 Arip MA, Yee LS, Karim BA. 2010. Export diversification and economic growth in Malaysia.
586 *Munich Personal RePEc Archive* **Paper 20588.**

587 Arouri MEH, Youssef AB, M'henni H, Raul C. 2012. Energy consumption, economic growth and
588 CO_2 emissions in Middle East and North African countries. *Energy Policy* **45**: 342-349.
589 doi:10.1016/j.enpol.2012.02.042
590 Atici C. 2012. Carbon emissions, trade liberalization, and the Japan-ASEAN interaction: A group-
591 wise examination. *Journal of the Japanese and International Economies* **26** (1): 167-178.
592 https://doi.org/10.1016/j.jjie.2011.07.006
593 Awad A, Abugamos H, 2017. Income-carbon emissions nexus for Middle East and North Africa
594 countries: A semi-parametric approach. *International Journal of Energy Economics and Policy* **7** (2):
595 152-159.
596 Ben Jebli M, Youssef SB. 2015. The environmental Kuznets curve, economic growth, renewable
597 and non-renewable energy, and trade in Tunisia. *Renewable and Sustainable Energy Reviews* **100**
598 (47): 173-185. DOI 10.1016/j.rser.2015.02.049
599 Ben Jebli M, Youssef SB, Ozturk I. 2016. Testing environmental Kuznets curve hypothesis: The
600 role of renewable and non-renewable energy consumption and trade in OECD
601 Countries. *Ecological Indicators* **60**: 824-831. http://dx.doi.org/10.1016/j.ecolind.2015.08.031
602 Bu M, Lin CT, Zhang B. 2016. Globalization and climate change: New empirical panel data
603 evidence. *Journal of Economic Surveys* **30** (3): 577-595. doi: 10.1111/joes.12162
604 Bulut U. 2017. The impacts of non-renewable and renewable energy on CO_2 emissions in Turkey.
605 *Environmental Science and Pollution Research* **24** (18): 15416-
606 15426. https://doi.org/10.1007/s11356-017-9175-2
607 Cai Y, Sam CY, Chang T. 2018. Nexus between clean energy consumption, economic growth and
608 CO_2 emissions. *Journal of Cleaner Production* **182**: 1001-1011.
609 https://doi.org/10.1016/j.jclepro.2018.02.035
610 Can M, Gozgor G. 2017. The impact of economic complexity on carbon emissions: evidence from
611 France. *Environmental Science and Pollution Research* **24** (19): 16364-16370. DOI
612 10.1007/s11356-017-9219-7
613 Cadot O, Céline C, Strauss-Kahn V. 2011. Export diversification: What's behind the hump?. *The*
614 *Review of Economics and Statistics* **93** (2): 590-605.
615 Chen JH, Huang YF. 2013. The study of the relationship between carbon dioxide (CO_2) emission
616 and economic growth. *Journal of International and Global Economic Studies* **6** (2): 45-61.
617 Chow GC. 2014. Environmental Kuznets curve: Conclusive econometric evidence for CO_2. *Pacific*
618 *Economic Review* **19** (1): 1-7. doi: 10.1111/1468-0106.12048

619 Diao XD, Zeng SX, Tam CM, Vivian WYT. 2009. EKC analysis for studying economic growth
620 and environmental quality: A case study in China. *Journal of Cleaner Production* **17** (5): 541-548.
621 doi:10.1016/j.jclepro.2008.09.007
622 Dinda S. 2004. Environmental Kuznets curve hypothesis: A survey. *Ecological Economics* **49** (4): 431-
623 455. https://doi.org/10.1016/j.ecolecon.2004.02.011
624 Dogan E, Turkekul B. 2016. CO_2 emissions, real output, energy consumption, trade, urbanization
625 and financial development: Testing the EKC hypothesis for the USA. *Environmental Science*
626 *and Pollution Research* **23**: 1203-1213. DOI 10.1007/s11356-015-5323-8
627 Engle RF, Granger CWJ. 1987. Co-integration and error correction: Representation, estimation,
628 and testing. *Econometrica* **55** (2): 251-276.
629 Fang J, Gozgor G, Lu Z, Wu W. 2019. Effects of the export product quality on carbon dioxide
630 emissions: Evidence from developing economies. *Environmental Science and Pollution*
631 *Research* **26** (12): 12181-12193. https://doi.org/10.1007/s11356-019-04513-7
632 Farooq S, Ozturk I, Majeed MT, Akram R. 2022. Globalization and CO2 emissions in the presence
633 of EKC: A global panel data analysis. *Gondwana Research*. doi: https://doi.org/10.1016/
634 j.gr.2022.02.002
635 Gozgor G. 2017. Does trade matter for carbon emissions in OECD countries? Evidence from a
636 new trade openness measure. *Environmental Science and Pollution Research* **24** (36): 27813-27821.
637 https://doi.org/10.1007/s11356-017-0361-z
638 Gozgor G, Can M. 2016. Export product diversification and the environmental Kuznets Curve:
639 Evidence from Turkey. *Environmental Science and Pollution Research* **23** (21): 21594-21603. DOI
640 10.1007/s11356-016-7403-9
641 Gozgor G, Can M. 2017. Does export product quality matter for CO_2 emissions? Evidence from
642 China. *Environ Sci Pollut Res* **24**: 2866-2875. DOI 10.1007/s11356-016-8070-6
643 Granger CWJ, Yoon G. 2002. Hidden cointegration. *University of California Working Paper* **2002-02.**
644 Grossman GM, Krueger AB. 1991. Environmental impacts of a North American Free Trade
645 Agreement. *National Bureau of Economic Research Working Paper* **3914.**
646 Halkos GE. 2011. Environment and economic development: Determinants of an EKC hypothesis.
647 *Munich Personal RePEc Archive Paper* **33262.**
648 Hamed K, Hadi D, Hossein K. 2014. Export diversification and economic growth in some selected
649 developing countries. *African Journal of Business Management* **8** (17): 700-704.
650 Hanif I, Raza SMF, Gago-de-Santos P, Abbas Q. 2019. fossil fuels, foreign direct investment, and
651 economic growth have triggered CO_2 emissions in emerging Asian economies: Some
652 empirical evidence. *Energy* **171**: 493-501. https://doi.org/10.1016/j.energy.2019.01.011

Haseeb A, Xia E, Danish MAB, Abbas K. 2018. Financial development, globalization, and CO_2 emission in the presence of EKC: evidence from BRICS countries. *Environmental Science and Pollution Research* **25** (31): 31283-31296. https://doi.org/10.1007/s11356-018-3034-7

Hatemi-J A. 2012. Asymmetric causality tests with an application. *Empirical Economics* **43** (1): 447-456. DOI 10.1007/s00181-011-0484-x

Henn C, Papageorgiou C, Spatafora N. 2015. Export quality in advanced and developing economies: Evidence from a new dataset. *WTO Working Paper* **ERSD-2015-02.**

Hesse H. 2008. Export diversification and economic growth. *Commission on Growth and Development Working Paper* **21.**

Hossain MS. 2011. Panel estimation for CO_2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries. *Energy Policy* **39** (11): 6991-6999. doi:10.1016/j.enpol.2011.07.042

IEA. 2019. International Energy Agency. https://www.iea.org/ (accessed January 31, 2021).

IMF. 2022. International Monetary Found. Statistical Database. https://www.imf.org/en/Data (accessed January 02, 2022).

Iwata H, Okada K, Samreth S. 2010. Empirical study on the environmental Kuznets curve for CO_2 in France: The role of nuclear energy. *Energy Policy* **38** (8): 4057-4063. https://doi.org/10.1016/j.enpol.2010.03.031

Jalil A, Mahmud SF. 2009. Environment Kuznets curve for CO_2 emissions: a cointegration analysis for China. *Energy Policy* **37** (12): 5167–5172. doi:10.1016/j.enpol.2009.07.044

Jayanthakumaran K, Verma R, Liu L. 2012. CO_2 emissions, energy consumption, trade and income: a comparative analysis of China and India. *Energy Policy* **42**: 450-460. doi:10.1016/j.enpol.2011.12.010

Johansen S, Juselius K. 1990. Some structural hypotheses in a multivariate cointegration analysis of the purchasing power parity and the uncovered ınterest parity for UK. *University of Copenhagen Department of Economics Discussion Papers* **90-05.**

Kasman A, Duman YS. 2015. CO_2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: A panel data analysis. *Economic Modelling* **44**: 97-103. http://dx.doi.org/10.1016/j.econmod.2014.10.022

Khan I, Zakari A, Ahmad M, Irfan M, Hou F. 2022. Linking energy transitions, energy consumption, and environmental sustainability in OECD countries. *Gondwana Research* **103**: 445-457. https://doi.org/10.1016/j.gr.2021.10.026.

Kim S, Lee JW, Park CY. 2011. Emerging Asia: Decoupling or recoupling. *The World Economy* **34** (1): 23-53. doi: 10.1111/j.1467-9701.2010.01280.x

687 Koc S, Bulus GC. 2020. Testing validity of the EKC hypothesis in South Korea: Role of renewable
688 energy and trade openness. *Environmental Science and Pollution Research* **27**: 29043-29054.
689 https://doi.org/10.1007/s11356-020-09172-7
690 Kumari A, Sharma AK. 2016. Analyzing the causal relations between electric power consumption
691 and economic growth in India. *The Electricity Journal* **29** (4): 28-35.
692 https://doi.org/10.1016/j.tej.2016.04.008
693 Lau LS, Choong CK, Eng YK. 2014. Investigation of the environmental Kuznets curve for carbon
694 emissions in Malaysia: Do foreign direct investment and trade matter?. *Energy Policy* **68**: 490-
695 497. http://dx.doi.org/10.1016/j.enpol.2014.01.002
696 Le TH, Quah E. 2018. Income level and the emissions, energy, and growth nexus: Evidence from
697 Asia and the Pacific. *International Economics* **156**: 193-205.
698 http://dx.doi.org/10.1016/j.inteco.2018.03.002
699 Lean HH, Smyth R. 2010. CO_2 emissions, electricity consumption and output in ASEAN. *Applied*
700 *Energy* **87** (6): 1858-1864. doi:10.1016/j.apenergy.2010.02.003
701 Linh DH, Lin SM. 2015. Dynamic causal relationships among CO_2 emissions, energy consumption,
702 economic growth and FDI in the most populous Asian Countries. *Advances in Management and*
703 *Applied Economics* **5** (1): 69-88.
704 Liu H, Kim H, Liang S, Kwon OS. 2018. Export diversification and ecological footprint: A
705 comparative study on EKC theory among Korea, Japan, and China. *Sustainability* **10** (3657):
706 1-12. doi:10.3390/su10103657
707 Mania E. 2019. Export diversification and CO_2 emissions: an augmented environmental Kuznets
708 Curve. *Journal of International Development* **32**: 168-185. DOI: 10.1002/jid.3441
709 Mikayilov JI, Galeotti M, Hasanov FJ. 2018. The impact of economic growth on CO_2 emissions in
710 Azerbaijan. *Journal of Cleaner Production* **197**: 1558-1572.
711 https://doi.org/10.1016/j.jclepro.2018.06.269
712 Mirza FM, Kanwal A. 2017. Energy consumption, carbon emissions and economic growth in
713 Pakistan: Dynamic Causality Analysis. *Renewable and Sustainable Energy Reviews* **72**: 1233-1240.
714 http://dx.doi.org/10.1016/j.rser.2016.10.081
715 Mirza FM, Sinha A, Khan JR, Kalugina OA, Zafar MW. 2022. Impact of energy efficiency on CO2
716 Emissions: Empirical evidence from developing countries. *Gondwana Research* **106**: 64-77.
717 https://doi.org/10.1016/j.gr.2021.11.017.
718 Moghadam HE, Dehbashi V. 2018. The impact of financial development and trade on
719 environmental quality in Iran. *Empirical Economics* **54** (4): 1777-1799.
720 https://doi.org/10.1007/s00181-017-1266-x

721 Mudenda C, Choga I. Chigamba C. 2014. The role of export diversification on economic growth
722 in South Africa. *Mediterranean Journal of Social Sciences* **5** (9): 705-712.
723 Doi:10.5901/mjss.2014.v5n9p705
724 Narayan PK, Narayan S. 2010. Carbon dioxide emissions and economic growth: panel data
725 evidence from developing countries. *Energy Policy* **38** (1): 661-666.
726 doi:10.1016/j.enpol.2009.09.005
727 Oktavilia S, Sugiyanto FX, Firmansyah F, Widodo W. 2017. Environmental degradation, trade
728 openness, and economic growth in Southeast Asian countries. *Pertanika Journal of Social*
729 *Sciences & Humanities (JSSH)* **25**: 175-185.
730 Onafowora OA, Owoye O. 2014. Bounds testing approach to analysis of the environment Kuznets
731 curve hypothesis. *Energy Economics* **44**: 47-62. http://dx.doi.org/10.1016/j.eneco.2014.03.025
732 Ozcan B. 2013. The nexus between carbon emissions, energy consumption and economic growth
733 in Middle East countries: a panel data analysis. *Energy Policy* **62**: 1138-1147.
734 http://dx.doi.org/10.1016/j.enpol.2013.07.016
735 Ozturk I, Acaravci A. 2013. The long-run and causal analysis of energy, growth, openness and
736 financial development on carbon emissions in Turkey. *Energy Economics* **36**: 262-267.
737 https://doi.org/10.1016/j.eneco.2012.08.025
738 Ozturk I. 2015. Sustainability in the food-energy-water nexus: Evidence from BRICS (Brazil, the
739 Russian Federation, India, China, and South Africa) countries. *Energy* **93**: 999-1010.
740 http://dx.doi.org/10.1016/j.energy.2015.09.104
741 Pao HT, Tsai CM. 2010. CO_2 emissions, energy consumption and economic growth in BRIC
742 countries. *Energy Policy* **38** (12): 7850-7860. doi:10.1016/j.enpol.2010.08.045
743 Paweenawat SW, Plyngam S. 2017. Does the causal relationship between renewable energy
744 consumption, CO_2 Emissions, and economic growth exist in Thailand? An ARDL
745 approach. *Economics Bulletin* **37** (2): 697-711.
746 Pesaran MH, Shin Y, Smith JR. 2001. Bounds testing approaches to the analysis of level
747 relationships. *Journal of Applied Econometrics* **16** (3): 289-326. DOI: 10.1002/jae.616
748 Phillips PCB, Hansen BE. 1990. Statistical inference in instrumental variables regression with I(1)
749 Processes. *The Review of Economic Studies* **57** (1): 99-125.
750 Rana R, Sharma M. 2019. Dynamic causality testing for EKC hypothesis, pollution haven
751 hypothesis and international trade in India. *The Journal of International Trade & Economic*
752 *Development* **28** (3): 348-364. https://doi.org/10.1080/09638199.2018.1542451
753 Rauf A, Liu X, Amin W, Ozturk I, Rehman OU, Hafeez M. 2018. Testing EKC hypothesis with
754 energy and sustainable development challenges: A fresh evidence from Belt and Road

Initiative Economies. *Environmental Science and Pollution Research* **25** (32): 32066-32080. https://doi.org/10.1007/s11356-018-3052-5

Saboori B, Sulaiman JB, Mohd S. 2012. An empirical analysis of the environmental Kuznets curve for CO_2 emissions in Indonesia: The role of energy consumption and foreign trade. *International Journal of Economics and Finance* **4** (2): 243-251. doi:10.5539/ijef.v4n2p243

Saboori B, Sulaiman J. 2013. Environmental degradation, economic growth and energy consumption: Evidence of the environmental Kuznets curve in Malaysia. *Energy Policy* **60**: 892-905. https://doi.org/10.1016/j.enpol.2013.05.099

Saidi K, Mbarek MB. 2017. The impact of income, trade, urbanization, and financial development on CO_2 emissions in 19 emerging economies. *Environmental Science and Pollution Research* **24** (14): 12748-12757. DOI 10.1007/s11356-016-6303-3

Salim RA, Rafiq S, Shafiei S. 2017. Urbanization, energy consumption, and pollutant emission in Asian developing economies: an empirical analysis. *ADBI Working Paper* **718.**

Seriño MNV, Klasen S. 2015. Estimation and determinants of the Philippines' household carbon footprint. *The Developing Economies* **53** (1): 44-62. doi: 10.1111/deve.12065

Shahbaz M, Gozgor G, Hammoudeh S. 2019. Human capital and export diversification as new determinants of energy demand in the United States. *Energy Economics* **78**: 335-349. https://doi.org/10.1016/j.eneco.2018.11.016

Shahbaz M, Mallick H, Mahalik MK, Loganathan N. 2015a. Does globalization impede environmental quality in India?. *Ecological Indicators* **52**: 379-393. https://doi.org/10.1016/j.ecolind.2014.12.025

Shahbaz M, Khan S, Ali A, Bhattacharya M. 2015b. The impact of globalization on CO_2 emissions in China. *Munich Personal RePEc Archive Paper* **64450.**

Shahbaz M, Sbia R, Hamdi H, Ozturk I. 2014. Economic growth, electricity consumption, urbanization and environmental degradation relationship in United Arab Emirates. *Ecological Indicators* **45**: 622-631. http://dx.doi.org/10.1016/j.ecolind.2014.05.022

Shahbaz M, Sinha A. 2019. Environmental Kuznets curve for CO_2 emissions: A literature survey. *Journal of Economic Studies* **46** (1): 106-168. DOI 10.1108/JES-09-2017-0249

Sinha A. 2015. Quadrilateral causal analysis of economic growth in India. *International Journal of Green Economics* **9(3-4)**: 215-225.

Sirag A, Matemilola BT, Law SH, Bany-Ariffin AN. 2018. Does environmental Kuznets curve hypothesis exist? Evidence from dynamic panel threshold. *Journal of Environmental Economics and Policy* **7** (2): 145-165. https://doi.org/10.1080/21606544.2017.1382395

24

788 Solarin SA, Al-Mulali U, Ozturk I. 2017. Validating the environmental Kuznets curve hypothesis
789 in India and China: The role of hydroelectricity consumption. *Renewable and Sustainable Energy*
790 *Reviews* **80**: 1578-1587. http://dx.doi.org/10.1016/j.rser.2017.07.028
791 Sugiawan Y, Managi S. 2016. The environmental Kuznets curve in Indonesia: exploring the
792 potential of Renewable Energy. *Energy Policy* **98**: 187-198.
793 http://dx.doi.org/10.1016/j.enpol.2016.08.029
794 Stock JH, Watson WM. 1993. A simple estimator of cointegrating vectors in higher order integrated
795 systems. *Econometrica* **61** (4): 783-820.
796 Tan D, Adedoyin FF, Alvarado R, Ramzan M, Kayesh MS, Shah MI. 2022. The effects of
797 environmental degradation on agriculture: Evidence from European countries. *Gondwana*
798 *Research* **106**: 92-104. https://doi.org/10.1016/j.gr.2021.12.009
799 Usman O, Iorember PT, Olanipekun OI. 2019. Revisiting the environmental Kuznets curve (EKC)
800 hypothesis in India: the effects of energy consumption and democracy. *Environmental Science*
801 *and Pollution Research* **26** (13): 13390-13400. https://doi.org/10.1007/s11356-019-04696-z
802 Wada I, Faizulayev A, Bekun FV. 2021. Exploring the role of conventional energy consumption
803 on environmental quality in Brazil: evidence from cointegration and conditional causality.
804 *Gondwana Research* **98**: 244-256. https://doi.org/10.1016/j.gr.2021.06.009
805 World Bank. 2022. World Development Indicator.
806 https://databank.worldbank.org/source/world-development-indicators (accessed January
807 01, 2022).
808 Yang X, Li N, Mu H, Ahmad M, Meng X. 2022. Population aging, renewable energy budgets and
809 environmental sustainability: Does health expenditures matter?. *Gondwana Research* **106**: 303-
810 314. https://doi.org/10.1016/j.gr.2022.02.003
811 Yin J, Zheng M, Chen J. 2015. The effects of environmental regulation and technical progress on
812 CO_2 Kuznets curve: an evidence from China. *Energy Policy* **77**: 97-108.
813 http://dx.doi.org/10.1016/j.enpol.2014.11.008
814 Zaidi SAH, Zafar MW, Shahbaz M, Hou F. 2019. Dynamic linkages between globalization,
815 financial development and carbon emissions: evidence from Asia Pacific Economic
816 Cooperation countries. *Journal of Cleaner Production* **228**: 533-543.
817 https://doi.org/10.1016/j.jclepro.2019.04.210
818 Zakaria M, Bibi S. 2019. Financial development and environment in South Asia: The role of
819 ınstitutional quality. *Environmental Science and Pollution Research* **26** (8): 7926-7937.
820 https://doi.org/10.1007/s11356-019-04284-1

821 Zhang S, Liu X, Bae J. 2017. Does trade openness affect CO_2 emissions: Evidence from ten newly
822 industrialized countries?. *Environmental Science and Pollution Research* **24** (21): 17616-17625.
823 DOI 10.1007/s11356-017-9392-8
824 Zhang S. 2018. Is trade openness good for environment in South Korea? The role of non-fossil
825 electricity consumption. *Environmental Science and Pollution Research* **25** (10): 9510-9522.
826 https://doi.org/10.1007/s11356-018-1264-3
827
828

26

27