Does International Cooperation Affect CO_2 Emissions? Evidence from OECD Countries

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Abstract

This paper analyzes the role of international cooperation on CO_2 emissions growth in 36 OECD economies over the period 1970–2016. The indices of political globalization are the benchmark measure of international cooperation since a higher value of the index of political globalization is an indicator of collaboration in the world. The paper finds that political globalization decreases CO_2 emissions growth. The findings remain robust when we consider the sub-indices of political globalization and include various controls. Also, the findings of the panel quantile regressions with the fixed-effects via the method of moments indicate that the effects of per capita income and the initial level of CO_2 emissions are higher in more pollutant countries. However, the impact of political globalization on CO_2 emissions is stable at different quantiles. The paper also discusses the potential implications for the role of international cooperation on climate change.

Keywords: CO_2 emissions growth; international cooperation; political globalization; climate change; advances economies; quantile regressions with fixed effects

1. Introduction

In the 21st century world, climate change is one of the most critical problems. The primary cause of climate change is the warming of the globe, which is closely related to greenhouse gas emissions and environmental degradation. 2015 United Nations Climate Change Conference concluded that decreasing the level of greenhouse gas emissions will slow down global warming and substantially reduce the risks and adverse effects of climate change (United Nations, 2015). Therefore, there has been a significant increase in empirical studies to examine the drivers of environmental degradation, particularly in the late 2010s. Despite there are various indicators of environmental degradation, the most used indicator in the empirical studies is CO_2 emissions (Solarin and Al-Mulali, 2018).

According to the previous literature, there are economic, political, and social aspects to affect CO_2 emissions growth. Technology also matters for CO_2 emissions. At this point, previous empirical studies have mostly focused on economic indicators and technology as the main drivers of CO_2 emissions. The Environmental Kuznets Curve (EKC) hypothesis introduced by Grossman and Krueger (1995) states a positive impact of income on CO_2 emissions, but the effect of income on CO_2 emissions should be negative when a country develops. This turn in the relationship between income and CO_2 emissions is mainly explained by the demand for a cleaner environment in the country. Overall, EKC hypothesis takes economic and social determinants of CO_2 emissions into account (Wang et al., 2019).

The technological process is also an essential part of the production that can affect CO_2 emissions. However, technological development itself cannot reduce CO_2 emissions; on the contrary, it should be adapted to the production process with the regulations set by policymakers. At this stage, the rules to be taken into consideration in production generally based on the country's energy usage and natural resource rents (Chen and Chen, 2011).

Therefore, in this paper, we consider an updated version of EKC and include energy consumption and natural resources along with the per capita income in the estimations.[1]

Consequently, this paper aims to explore the drivers of CO_2 emissions, but the unique role is given to political determinants of CO_2 emissions, which is international cooperation in our research. Theoretical foundations of CO_2 emissions-international governance nexus can be found in the "new institutionalism" approach (Scott, 2008). Specifically, the World Polity Theory (henceforth WPT) indicates that cultural, social, and political aspects of globalization determine individuals' and policymakers' decision making processes across the countries, and there is a significant convergence of social life among the nations because of globalization (Meyer, 2010).[2] The WPT also suggests that globalization promotes international governance by constructing similar institutions and governance procedures as well as by creating similar cultures. These issues of globalization will also lead to a global environmental regime (Frank et al., 2000). At this stage, a higher value of political globalization, the benchmark measure of international governance, encourages international collaborations and formal or informal international relations. Political globalization also promotes to build up standard environmental regimes and protect the interest of the globe. Note that the largest countries should form a global ecological system, and they should define their primary objective to decrease environmental degradation. That's why we focus on OECD countries, which of them are mostly the advanced economies.

By signing international legal treaties and bilateral investment treaties (BITs) as well as and participating international inter-governmental and non-governmental organizations, countries can contribute to building up the global environmental regime (Jackson et al., 2018).

[1] Theoretically speaking, natural resource rents (particularly oil rents) lead to greater CO_2 emissions. However, the impact of energy usage on CO_2 emissions is mixed, depends on the sample of countries (see, e.g., Acheampong, 2018).

[2] There are also game-theory approaches to the relationship between climate change and international governance (see, e.g., Hammitt and Adams, 1996).

According to Frank et al. (2000) and Meyer (2010), environmental international non-government organizations (EINGO) has an essential role in decreasing CO_2 emissions and thus to slow down global warming. EINGOs can ascertain market failures, execute environmental regulations, make provision, raise awareness in climate change, suggest policy implications, and encourage negotiations among countries (Longhofer and Jorgenson, 2017). Overall, the WPT indicates that the political dimension of globalization can affect climate change, and a higher level of political integration among OECD countries should decrease their growth rate of CO_2 emissions over time. In short, the political dimension of globalization can reduce risks and adverse effects of climate change due to environmental degradation at the country level and global warming.

At this point, this paper analyzes the effects of indices of political globalization (as a benchmark measure of international cooperation) on the growth rate of CO_2 emissions 36 OECD countries over the period 1970–2016. In so doing, we utilize random-effects estimations and test the efficiency of random-effects estimators by applying Hausman test. We also employ the panel quantile regressions with the fixed-effects via the method of moments (henceforth PQR-FEMM). We find that a higher value of the index of political globalization is an indicator of higher cooperation in the world. Our results provide empirical contributions to the CO_2 emissions-international governance nexus.

At this stage, we use the revisited KOF indices of political globalization, which has initially developed by Dreher (2006) and has expanded by Gygli et al. (2019) since they can cover all dimensions of political globalization. The revisited KOF indices of political globalization are perfect candidates to examine their effects on the growth rate of CO_2 emissions. To the best of the authors' knowledge, this paper demonstrates the first empirical evidence by considering the revisited measure of the KOF political globalization indices as the potential drivers of CO_2 emissions in the OECD countries. The paper finds that political

globalization decreases CO_2 emissions growth. The findings remain robust when we consider the sub-indices of political globalization and include various controls and different econometric techniques.

The remaining parts of the study are structured as follows. Section 2 provides a brief literature review on drivers of CO_2 emissions. Section 3 introduces the data and model, as well as the estimation procedure. Section 4 discusses the empirical results with possible implications as well as implements the robustness checks for the main findings. Section 5 concludes.

2. Literature Review

2.1 Theoretical Background

Various papers have utilized the panel data estimation techniques to explore the drivers of CO_2 emissions in the advanced countries and the developing economies.[3] The first group of studies has just focused on the effects of income on CO_2 emissions (Dinda, 2004). The second group of studies has used income and energy consumption as the potential drivers of CO_2 emissions (Acheampong, 2018).[4] According to the studies in these groups, income and energy consumption should be the benchmark controls for empirical models of CO_2 emissions. The third group of studies has used another indicator(s) to investigate its impact on CO_2 emissions. Most of these papers have utilized panel data estimation techniques, and they have also considered income and energy consumption or both as main controls (see, e.g., Ahmed et al., 2016; Apergis et al., 2018; Can and Gozgor, 2017; Gozgor, 2017; Ozcan et al., 2018; Zhang et al., 2017).

[3] Various papers have also conducted the time-series analyses to examine the determinant factors of CO_2 emissions (e.g., Chang et al., 2019; Chen et al., 2019a and 2019b; Gozgor and Can, 2017; Ling et al., 2015; Shahbaz et al., 2013).
[4] Al-Mulali and Ozturk (2016) and Farhani and Ozturk (2015) provide an excellent review of the related literature.

A growing number of studies have used the indices of globalization (i.e., the KOF indices of economic, political, social, and overall globalization) in the empirical literature.[5] Different from these studies, our paper uses the revisited version of the KOF index of political globalization. Compared to its previous versions, the KOF index of political globalization considers more comprehensive variables to construct the baseline index (Gygli et al., 2019). Besides, the coverage of the data is better than previous versions in terms of the number of countries and the time coverage. That's why we have used the revisited version of the KOF index of political globalization.[6]

2.2 Previous Empirical Studies

At this point, there are various papers to consider time-series analysis and panel data estimation techniques. For example, using the time-series techniques incorporating structural breaks, Shahbaz et al. (2015) investigate the effects of globalization on CO_2 emissions in India for the period from 1970 to 2012. The empirical models in the paper also control effects of income, energy consumption, and financial development. The authors find that EKC hypothesis is valid in India, and all variables (income, energy consumption, financial development, and globalization indices) lead to higher CO_2 emissions in the country. Besides, using the time-series analysis with the structural breaks, Shahbaz et al. (2017) examine the impact of globalization indices on CO_2 emissions in China for the period from 1970 to 2012. According to the results, income and coal consumption lead to an increase in CO_2 emissions. However, globalization (measured by overall KOF index and its sub-indices) reduces CO_2 emissions in China, meaning that policymakers should increase the integration to the world markets to decrease environmental degradation in China. Haseeb et al. (2018) extend the findings from

[5] Bu et al. (2016) have reviewed the previous papers for the impacts of the KOF indices of globalization on environmental variables until 2015. Therefore, our review of the previous literature will focus on the empirical studies conducted after 2015.

[6] There are also empirical studies to use different indicators of international political integration, rather than the KOF indices of globalization, to analyze their effects on environmental indicators (see, e.g., Longhofer and Jorgenson, 2017).

China and India to the case of the BRIC countries. The authors utilize both the time-series analysis and the panel data estimation techniques to examine the determinants of CO_2 emissions following EKC model. The empirical results from panel data analysis demonstrate that EKC hypothesis is valid, and energy consumption and financial development lead to higher CO_2 emissions in BRIC countries. However, globalization and urbanization have adverse, but statistically insignificant effects on CO_2 emissions. Time-series analyses also document the mixed results, and consequently, globalization does not have a significant impact on CO_2 emissions in BRIC countries. Using the threshold-based time-series analysis with regime-switching, Shahbaz et al. (2018) explore effects of globalization on CO_2 emissions in Japan for the period from 1970 to 2014. The empirical models in the paper also include the role of income and energy consumption. The authors observe that a higher level of globalization raises CO_2 emissions in Japan. Energy consumption and income both yield higher CO2 emissions in the country. Applying the time-series analysis, Khan and Ullah (2019) investigate the effects of income and globalization on CO_2 emissions in Pakistan over the period 1975-2014. The findings demonstrate the validity of the EKC hypothesis in Pakistan. Moreover, all dimensions of globalization lead to higher CO_2 emissions.

There are also several studies to implement panel data estimation techniques to examine the impact of globalization on environmental degradation in both developing economies and advanced countries. For instance, Zafar et al. (2019) analyze the role of energy consumption, financial development, and globalization in determining CO_2 emissions in the selected OECD countries for the period from 1990 to 2014. The authors implement the panel data techniques to estimate an EKC model. The authors observed the validity of EKC model, and there is a positive impact of energy consumption on CO_2 emissions. Besides, financial development and globalization lead to lower CO2 emissions in the selected OECD countries. Using the panel data estimation approaches, Rahman et al. (2019) analyze the effects of energy consumption,

financial development, and globalization on CO_2 emissions in the panel data of 16 Central and Eastern European (CEE) economies over the period 1980-2016. The results indicate the validity of EKC hypothesis in the CEE countries over the period under concern. Globalization decreases CO_2 emissions, but energy consumption raises CO_2 emissions. Moreover, financial development does not have a significant impact on CO_2 emissions.

Similarly, Destek (2019) analyzes effects of different aspects of globalization on CO_2 emissions in the CEE countries over the period 1995-2015. The author observes the validity of EKC model, and there is an insignificant effect of energy consumption on CO_2 emissions. Besides, globalization enhances CO_2 emissions, but the evidence is not robust to consider different aspects of globalization. Finally, using the panel data analysis methods, Zaidi et al. (2019) explore the effects of energy intensity, financial development, and globalization on CO_2 emissions in the Asia Pacific Economic Cooperation (APEC) economies for the period from 1990 to 2016. The authors conclude the validity of EKC hypothesis since income and energy intensity increase CO_2 emissions. Besides, the results show that both financial development and globalization decrease the CO_2 emissions in the APEC countries over the period under concern.

To conclude the review of previous papers, this paper focuses on the revisited measures of political globalization as a potential driver of CO_2 emissions. To stay linked to prior articles, we include various controls. Rather than focusing on a single country (e.g., China, India, etc.), we focus on the panel dataset of 36 OECD countries. We also consider a more extended period (from 1970 to 2016) with the five-year average growth rate of CO_2 emissions in the non-overlapping periods. Addressing these gaps, we aim to enhance the knowledge for the impact of political globalization on CO_2 emissions in OECD countries. At this stage, we also include various control variables and check the robustness of the main results by implementing different estimation techniques, such as the random-effects and the PQR-FEMM.

3. Data, Model, and Estimation Procedure

3.1 Data

This paper analyzes the effects of indices of political globalization on CO_2 emissions growth in 36 OECD countries over the period 1970-2016. The left-side variable is the (average) growth rate of CO_2 emissions (*co2ems*) in the five-year non-overlapping periods to capture a long term impact of political globalization on growth of the CO_2 emissions.[7] Therefore, we use 313 observations for each variable. In terms of explanatory variables, we use the initial level of CO_2 emissions in the logarithmic form (*in_co2ems*) in the overlapping periods to model the "convergence effect." Following previous papers, we include per capita gross domestic product (GDP) in the logarithmic form (*gdpc*), measured by current USD prices, to capture the "income effect" in CO_2 emissions. We also cover the energy consumption per capita in the logarithmic form (*lnengcon*) and the natural resource rents relative to GDP (*tot_nrr*) as additional controls in the modeling of CO_2 emissions. Data of co2ems, in_co2ems, and lnengcon are obtained from the Statistical Review of World Energy of British Petroleum (2019). Data of gdpc and tot_nrr are accessed from the World Development Indicators (WDI) dataset of the World Bank (2019).

Moreover, we use the indices of political globalization in logarithmic form, and the data are obtained from the KOF Globalization Index website of the ETH Zurich University. The KOF Globalization indices measure the economic, social, and political dimensions of globalization. The original index is developed by Dreher (2006), and it is expanded by Gygli et al. (2019). At this stage, the primary variable of interest is the index of overall political globalization (*kofpolg_ove*), which consists of the de facto index of political globalization (*kofpolg_df*) and the de jure index of political globalization (*kofpolg_dj*). Specifically, kofpolg_df includes i) the number of embassies in a country, ii) the number of personnel contributed to United Nations Security Council Missions, iii) number of internationally oriented

[7] In this paper, we consider a five-year (average) growth rate in non-overlapping periods in random-effects estimations since the index value of political globalization can significantly vary only in the long term.

non-governmental organizations (NGO) operating in a country. Besides, kofpolg_dj consists of i) number of memberships of international inter-governmental organizations, ii) international treaties signed between two or more states, iii) the number of distinct treaty partners of a country with bilateral investment treaties (BITs). Note that kofpolg_ove is the average of kofpolg_df and kofpolg_dj.[8] A summary of descriptive statistics and the definition of variables are also provided in Table 1.

[Insert Table 1 around here]

According to Table 1, the average growth rate of CO_2 is positive (0.393) during the period under concern. The highest value of the standard deviation is observed in natural resource rents, which is followed by CO_2 emissions growth.

Finally, we report a correlation matrix in Table 2 that represent pairwise correlations. We observe the negative correlations among co2ems and kofpolg_ove, kofpolg_df, and kofpolg_dj as well as co2ems, and controls except for tot_nrr.

[Insert Table 2 around here]

3.2 Model and Estimation Procedure

Capturing the effects of income, energy consumption, and natural resource rents, we examine impact of the measures of political globalization on CO_2 emissions. Thus, we can write the following model:

$$co2ems_{it} = f(in\_co2ems_{it}^{\lambda_1}, \text{gdpc}_{it}^{\lambda_2}, lnengcon_{it}^{\lambda_3}, \text{tot\_nrr}_{it}^{\lambda_4}, \text{kofpolg\_ove}_{it}^{\lambda_5}) \quad (1)$$

A primary model in Eq. (1) is estimated by using the growth rate of dependent variable that is the difference between the natural logarithms of the initial values and the final year of a five-year non-overlapping period. We can also write this empirical model as follows:

$$co2ems_{it} = \lambda_0 + \lambda_1 in\_co2ems_{it} + \lambda_2 \text{gdpc}_{it} + \lambda_3 lnengcon_{it} + \lambda_4 \text{tot\_nrr}_{it} + \lambda_5 \text{kofpolg\_ove}_{it} + \varepsilon_{it} \quad (2)$$

[8] For more details, visit the website of the KOF Institute.

In Eq. (2), $co2ems_{it}$ is per capita annualized growth rate of CO_2 emissions in country i at time t in_co2ems is a log of the initial per capita CO_2 emissions, kofpolg_ove_{it} is log of the political globalization index, gdpc_{it} is log of per capita income, $lnengcon_{it}$ is log of per capita energy consumption, and tot_nrr is natural resource rents relative to GDP. All explanatory variables are represented an "initial condition," i.e., a "first year of observation in any five-year non-overlapping period." ε_{it} denotes error terms.

One should expect that $\lambda_1 < 0$ due to the "convergence effect" of CO_2 emissions across OECD countries. One should also expect $\lambda_2 < 0$, $\lambda_3 < 0$, and $\lambda_4 < 0$ because a higher income, energy consumption, and natural resource rents should lead to higher growth of CO_2 emissions in advanced economies, such as the OECD countries.[9] Besides, the impact of the indices of political globalization on CO_2 emissions should be negative ($\lambda_5 < 0$) because international cooperation with investment and other types of agreements (e.g., trade agreements) can decrease CO_2 emissions growth.

We firstly estimate Eq. (1) via the random-effects estimation procedure with the robust standard errors following the results of the Hausman test. Since we use growth rates in the five-year non-overlapping periods, there is no problem with a unit root in the variables.[10] Furthermore, using growth rates over the long-run, we avoid a possible reverse causality issue[11]; and therefore, we do not have to apply a dynamic panel data estimation. We also use PQR-FEMM introduced by Machado and Santos Silva (2019) to obtain the findings from each quantile of 0.10. Therefore, we can evaluate whether there is a significant difference between

[9] Note that the effects of the related control variables on CO_2 emissions should be positive in developing countries.
[10] Note that we run the cross-sectional dependence (CD) test of Pesaran (2004). Following the findings, we utilize the second generation unit root test of Pesaran (2007). All findings confirm that all series are stationary. Related findings are not provided to save space, but they are available upon request.
[11] That is, greater CO_2 can negatively affect the level of political globalization.

the countries at the highest and the lowest levels of political globalization in terms of the impact of political globalization on CO_2 emissions growth.

4. Empirical Results

4.1 Benchmark Results: The Random-Effects Estimations

The findings of the random-effects estimations are provided in Table 3, which shows the drivers of CO_2 emissions in 36 OECD countries for the period from 1970 to 2016. Therefore, there are 313 observations in the empirical analysis.

[Insert Table 3 around here]

In Table 3, there are several results in different columns, but all of these results include the coefficients for log initial CO_2 emissions per capita and log GDP per capita. The findings indicate that there is a significant convergence among CO_2 emissions in OECD countries as it is expected. Besides, there is a negative impact of per capita GDP on CO_2 emissions growth. This evidence is in line with EKC hypothesis since most OECD countries are high-income countries. Therefore, as long as their income increase, this may lead to lower CO_2 emissions. The coefficients of the related controls are statistically significant at the 1% level. The results of the Hausman test also show that random-effects estimations are efficient.

The impact of political globalization on CO_2 emissions is always negative, and the coefficients are statistically significant at the 1% level. Column (1) includes the index of overall political globalization to examine its impact on CO_2 emissions. We observe the adverse effects of political globalization, and the coefficient is statistically significant at the 1% level. Column (2) considers both energy consumption and political globalization to analyze their impacts on CO_2 emissions. The effects of the related variables on CO_2 emissions are adverse, but the coefficient of energy consumption is not statistically significant. Column (3) adds natural resources rents, while Column (4) considers both energy consumption and natural resources

rents. According to the findings, energy consumption and natural resources rent negatively affect CO_2 emissions, but their coefficients are statistically insignificant. When we look deeper into the impact of political globalization on CO_2 emissions, it is found that a 1% percent increase in political globalization leads to a 2.4% increase (on average) in OECD countries.

Furthermore, Columns (5) and (6) report the results for the indices of the de facto- and the de jure political globalization. Since the de facto and the de jure measures of political globalization measures are somehow different, this issue may change the findings. The results indicate that both measures of political globalization negatively associated with CO_2 emissions growth. Although the coefficient of the de facto measure is statistically significant at the 1% level, the de jure measure is only significant at the 10% level. This evidence implies that the impact of international cooperation on climate change is dominated by the de facto indicators of political globalization, such as the numbers of embassies and non-governmental organizations (NGOs) in a country as well as personnel contributed to the United Nations Security Council Missions.

4.2 Robustness Checks: Results of PQR-FEMM Estimations

In Table 4, we report the findings for the PQR-FEMM estimations introduced by Machado and Santos Silva (2019). The main advantage of this method is that it can provide the impact of political globalization on CO_2 emissions growth at different quantiles. In so doing, the method includes the period- and the country fixed-effects, and this can help to model heterogeneities among countries over the period under concern.

[Insert Table 4 around here]

The findings from the PQR-FEMM estimations show that there are always negative coefficients in the related variables. Besides, the effects of the initial level of CO_2 emissions and per capita GDP are higher in more pollutant countries. However, the impact of political globalization on CO_2 emissions is stable at different quantiles. The coefficients of the index of

political globalization are statistically significant in every quantile; however, the factors for the "convergence effect" and the "income effect" are statistically significant from quantiles from 30% to 90%. In other words, these coefficients are statistically insignificant in the quantiles of 10% and 20% implying that there is no convergence in fewer pollutant countries, where the negative impact of income is valid. This evidence may be explained the fact that there are also a few developing countries (e.g., Chile, Mexico, and Turkey) in the dataset of OECD countries. Figure 1, where vertical line (Y-axis) is the coefficients, and horizontal line (X-axis) is the quantiles, also illustrates the effects of the initial level of CO_2 emissions, the per capita GDP, and the index of political globalization on CO_2 emissions growth and it gives us a clear cut for the findings in Table 4.

[Insert Figure 1 here]

4.3 Discussion of the Findings and Implications

According to the results, EKC hypothesis is valid in OECD countries because we obtain the significant positive effects of per capita income on CO_2 emissions. This evidence is parallel to the findings of various empirical papers and the theoretical expectation of EKC hypothesis. As long as countries grow, this should be yield higher CO_2 emissions. (Al-Mulali and Ozturk, 2016). Besides, we find an adverse but statistically insignificant effect of energy consumption and natural resource rents on CO_2 emissions.

The novel evidence in this paper is that a higher political integration suppresses CO_2 emissions in OECD countries. Therefore, supporting political globalization in OECD countries may lead not only to more international cooperation but also can provide solutions to the issues of climate change. Meanwhile, multilateral trade and investment agreements can include environmental issues. Besides, leading unions, such as the European Union (EU) and the North American Free Trade Agreement, can particularly address ecological problems in their meetings and regulations. The leading global institutions, such as the International Monetary

Fund, the United Nations, and the World Bank, should encourage policy implications, which will be designed to enhance political integration. At this stage, it can be essential to provide solutions to reduce environmental degradation by promoting the regulations on international trade with green products, and by supporting green-field foreign direct investments.

At this stage, the main policy implication is that increasing political integration should be a significant policy agenda for decreasing the negative consequences of climate change. However, further analysis at the country level can provide some more detailed policy implications. Nevertheless, solutions to the problems of climate change are not secure since there is a conflict of economic interests between advanced economies and developing economies. Unfortunately, the United States of America (USA)-China trade war is a current example of this conflict of interest.

5. Conclusion

In this paper, we examined the effects of international cooperation, measured by the KOF indices of political globalization, on CO_2 emissions growth in 36 OECD countries over the period 1970–2016. Higher values of political globalization indicate a more in-depth collaboration in the world (international cooperation). We found that a rise in the level of political globalization reduces CO_2 emissions growth. These results have been robust to use the sub-indices of political globalization and the inclusion of various controls. Besides, the PQR-FEMM indicated that the effects of per capita income and the initial level of CO_2 emissions are higher in more pollutant countries, but the impact of political globalization on CO_2 emissions is stable at different quantiles.

The empirical results in this paper have potential implications for the effects of international cooperation on climate change. The primary policy implication is that advanced economies should enhance political integration (global collaboration), and this policy will help

to reduce the growth rate of CO_2 emissions. Therefore, improving international cooperation among advanced economies can solve the potential problems of climate change. At this stage, there is a greater responsibility of large developed economies (e.g., EU countries and USA) since OECD countries do not include developing economies, such as China and India. If advanced countries can work together, this policy can decrease CO_2 emissions growth. Specifically, increasing the number of non-governmental organizations and international inter-governmental organizations can address problems due to climate change (Feng et al., 2018). Besides, a higher number of distinct treaty partners and bilateral investment treaties can aim to decrease CO_2 emissions growth. Historically, this kind of measure for political globalization has reduced CO_2 emissions, but more future cooperation is needed to be settled in today's highly-industrialized world economy.

Future papers on this topic can consider other measures of international cooperation as potential determinants of CO_2 emissions in large emerging economies. Future research can focus on the case of China or India, which can also be interesting to analyze their political integration on environmental degradation. Future papers can consider other environmental pollution measures, rather than. CO_2 emissions, to explain the impact of international cooperation on environmental degradation.

References

Acheampong, A.O. (2018). Economic Growth, CO_2 Emissions, and Energy Consumption: What Causes What and Where? *Energy Economics*, 74, 677–692.

Ahmed, K., Shahbaz, M., & Kyophilavong, P. (2016). Revisiting the Emissions-Energy-Trade Nexus: Evidence from the Newly Industrializing Countries. *Environmental Science and Pollution Research*, 23 (8), 7676–7691.

Al–Mulali, U., & Ozturk, I. (2016). The Investigation of Environmental Kuznets Curve Hypothesis in the Advanced Economies: The Role of Energy Prices. *Renewable and Sustainable Energy Reviews*, 54, 1622–1631.

Apergis, N., Can, M., Gozgor, G., & Lau, C.K.M. (2018). Effects of Export Concentration on CO_2 Emissions in Developed Countries: An Empirical Analysis. *Environmental Science and Pollution Research*, 25 (14), 14106–14116.

British Petroleum (2019). *BP Statistical Review of World Energy June 2019*. British Petroleum: London.

Bu, M., Lin, C–T., & Zhang, B. (2016). Globalization and Climate Change: New Empirical Panel Data Evidence. *Journal of Economic Surveys*, 30 (3), 577–595.

Can, M. & Gozgor, G. (2017). The Impact of Economic Complexity on Carbon Emissions: Evidence from France. *Environmental Science and Pollution Research*, 24 (19), 16364–16370.

Chang, C.P., Dong, M., Sui, B., & Chu, Y. (2019). Driving Forces of Global Carbon Emissions: From Time-and Spatial-dynamic Perspectives. *Economic Modelling*, 77, 70–80.

Chen, G.Q., & Chen, Z. M. (2011). Greenhouse Gas Emissions and Natural Resources Use by the World Economy: Ecological Input–output Modeling. *Ecological Modelling*, 222 (14), 2362–2376.

Chen, X., Chen, Y.E., & Chun-Ping, C. (2019a). The Effects of Environmental Regulation and Industrial Structure on Carbon Dioxide Emission: A Non-linear Investigation. *Environmental Science and Pollution Research*, 26 (29), 30252–30267.

Chen, Y.E., Fu, Q., Zhao, X., Yuan, X., & Chang, C P. (2019b). International Sanctions' Impact on Energy Efficiency in Target States. *Economic Modelling*, 82, 21–34.

Destek, M.A. (2019). Investigation on the Role of Economic, Social, and Political Globalization on Environment: Evidence from CEECs. *Environmental Science and Pollution Research*, forthcoming, https://doi.org/10.1007/s11356-019-04698-x, 1–14.

Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics*, 49 (4), 431–455.

Dreher, A. (2006). Does Globalization Affect Growth? Evidence from a New Index of Globalization. *Applied Economics*, 38 (10), 1091–1110.

Farhani, S., & Ozturk, I. (2015). Causal Relationship between CO_2 Emissions, Real GDP, Energy Consumption, Financial Development, Trade Openness, and Urbanization in Tunisia. *Environmental Science and Pollution Research*, 22 (20), 15663–15676.

Feng, G.F., Dong, M., Wen, J., & Chang, C.P. (2018). The Impacts of Environmental Governance on Political Turnover of Municipal Party Secretary in China. *Environmental Science and Pollution Research*, 25 (25), 24668–24681.

Frank, D.J., Hironaka, A., & Schofer, E. (2000). The Nation-state and the Natural Environment over the Twentieth Century. *American Sociological Review*, 65 (1), 96–116.

Gozgor, G. (2017). Does Trade Matter for Carbon Emissions in OECD Countries? Evidence from a New Trade Openness Measure. *Environmental Science and Pollution Research*, 24 (36), 27813–27821.

Gozgor, G., & Can, M. (2017). Does Export Product Quality Matter for CO_2 Emissions? Evidence from China. *Environmental Science and Pollution Research*, 24 (3), 2866–2875.

Grossman, G.M., & Krueger, A.B. (1995). Economic Growth and the Environment. *The Quarterly Journal of Economics*, 110 (2), 353–377.

Gygli, S., Haelg, F., Potrafke, N., & Sturm, J–E. (2019): The KOF Globalisation Index – Revisited. *Review of International Organizations*, 14 (3), 543–574.

Hammitt, J.K., & Adams, J.L. (1996). The Value of International Cooperation for Abating Global Climate Change. *Resource and Energy Economics*, 18 (3), 219–241.

Haseeb, A., Xia, E., Baloch, M.A., & 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.

Jackson, R., Sørensen, G., & Møller, J. (2018). *Introduction to International Relations: Theories and Approaches*. Seventh Edition, Oxford University Press: Oxford.

Khan, D., & Ullah, A. (2019). Testing the Relationship between Globalization and Carbon Dioxide Emissions in Pakistan: Does Environmental Kuznets Curve Exist? *Environmental Science and Pollution Research*, 26 (15), 15194–15208.

Ling, C.H., Ahmed, K., Muhamad, R.B., & Shahbaz, M. (2015). Decomposing the Trade-Environment Nexus for Malaysia: What Do the Technique, Scale, Composition, and Comparative Advantage Effect Indicate? *Environmental Science and Pollution Research*, 22 (24), 20131–20142.

Longhofer, W., & Jorgenson, A. (2017). Decoupling Reconsidered: Does World Society Integration Influence the Relationship between the Environment and Economic Development? *Social Science Research*, 65, 17–29.

Machado, J.A.F., & Santos Silva, J.M.C. (2019). Quantiles via Moments. *Journal of Econometrics*, 213 (1), 145–173.

Meyer, J.W. (2010). World Society, Institutional Theories, and the Actor. *Annual Review of Sociology*, 36, 1–20.

Ozcan, B., Apergis, N., & Shahbaz, M. (2018). A Revisit of the Environmental Kuznets Curve Hypothesis for Turkey: New Evidence from Bootstrap Rolling Window Causality. *Environmental Science and Pollution Research*, 25 (32), 32381–32394.

Pesaran, M.H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *Institute for the Study of Labor (IZA) Discussion Papers*, No. 1240, Bonn: Institute for the Study of Labor (IZA).

Pesaran, M.H. (2007). A Simple Panel Unit Root Test in the Presence of Cross-section Dependence. *Journal of Applied Econometrics*, 22 (2), 265–312.

Rahman, S–U., Chen, S., Saud, S., Bano, S., & Haseeb, A. (2019). The Nexus between Financial Development, Globalization, and Environmental Degradation: Fresh Evidence from Central and Eastern European Countries. *Environmental Science and Pollution Research*, 26 (24), 24733–24747.

Scott, W.R. (2008). *Institutions and Organizations: Ideas and Interests*. Third Edition, Sage Publications: Los Angeles, CA.

Shahbaz, M., Khan, S., Ali, A., & Bhattacharya, M. (2017). The Impact of Globalization on CO_2 Emissions in China. *The Singapore Economic Review*, 62 (4), 929–957.

Shahbaz, M., Mallick, H., Mahalik, M.K., & Loganathan, N. (2015). Does Globalization Impede Environmental Quality in India? *Ecological Indicators*, 52, 379–393.

Shahbaz, M., Muhammad, Q., Hye, A., Tiwari, A.K., & Leitão, N.C. (2013). Economic Growth, Energy Consumption, Financial Development, International Trade, and CO_2 Emissions in Indonesia. *Renewable and Sustainable Energy Reviews*, 25, 109–121.

Shahbaz, M., Shahzad, S.J.H., & Mahalik, M.K. (2018). Is Globalization Detrimental to CO_2 Emissions in Japan? New Threshold Analysis. *Environmental Modeling & Assessment*, 23 (5), 557–568.

Solarin, S.A., & Al-Mulali, U. (2018). Influence of Foreign Direct Investment on Indicators of Environmental Degradation. *Environmental Science and Pollution Research*, 25 (25), 24845–24859.

United Nations (2015). *Adoption of the Paris Agreement: Proposal by the President*. Draft Decision -/CP.21, December 12, 2015. United Nations: Paris.

Wang, Y., Zhou, T., Chen, H., & Rong, Z. (2019). Environmental Homogenization or Heterogenization? The Effects of Globalization on Carbon Dioxide Emissions, 1970–2014. *Sustainability*, 11 (10), 2752.

World Bank (2019). *World Development Indicators Database*. Washington, D.C.: World Bank.

Zafar, M.W., Saud, S., & Hou, F. (2019). The Impact of Globalization and Financial Development on Environmental Quality: Evidence from Selected Countries in the Organization for Economic Co-operation and Development (OECD). *Environmental Science and Pollution Research*, 26 (13), 13246–13262.

Zaidi, S.A.H., Zafar, M.W., Shahbaz, M., & Hou, F. (2019). Dynamic Linkages between Globalization, Financial Development and Carbon Emissions: Evidence from Asia Pacific Economic Cooperation Countries. *Journal of Cleaner Production*, 228, 533–543.

Zhang, S., Liu, X., & Bae, J. (2017). Does Trade Openness Affect CO_2 Emissions: Evidence from Ten Newly Industrialized Countries? *Environmental Science and Pollution Research*, 24 (21), 17616–17625.

Table 1
Summary of Descriptive Statistics (36 OECD Countries, 1970–2016)

Variable	Definition	Abbreviation	Data Source	Mean	Standard Deviation	Minimum	Maximum	Observations
Growth of CO_2 Emissions per Capita	Growth Rate	co2ems	British Petroleum (2019)	0.393	2.319	–5.859	9.241	313
CO_2 Emissions per Capita	Natural Logarithm	in_co2ems	British Petroleum (2019)	2.078	0.602	0.118	3.784	313
Gross Domestic Product per Capita	Natural Logarithm	gdpc	World Bank (2019)	9.414	1.111	5.631	11.64	313
Energy Consumption per Capita	Natural Logarithm	lnengcon	British Petroleum (2019)	1.242	0.652	–1.024	2.700	313
Natural Resource Rents	Relative to GDP	tot_nrr	World Bank (2019)	1.425	2.718	0.000	19.58	313
Political Globalization (Overall)	Natural Logarithm	KOFpolg_ove	KOF: Dreher (2006) & Gygli et al. (2019)	4.369	0.186	3.643	4.590	313
Political Globalization (De Facto)	Natural Logarithm	KOFpolg_df	KOF: Dreher (2006) & Gygli et al. (2019)	4.372	0.209	3.635	4.588	313
Political Globalization (De Jure)	Natural Logarithm	KOFpolg_dj	KOF: Dreher (2006) & Gygli et al. (2019)	4.354	0.231	3.321	4.602	313

Table 2
Correlation Matrix (36 OECD Countries, 1970–2016)

Regressors	co2ems	in_co2ems	gdpc	lnengcon	tot_nrr	KOFpolg_ove	KOFpolg_df	KOFpolg_dj
co2ems	1.000	–	–	–	–	–	–	–
in_co2ems	–0.414	1.000	–	–	–	–	–	–
gdpc	–0.505	0.529	1.000	–	–	–	–	–
lnencon	–0.441	0.861	0.679	1.000	–	–	–	–
tot_nrr	0.060	–0.159	–0.077	–0.072	1.000	–	–	–
KOFpolg_ove	–0.424	0.319	0.566	0.353	–0.032	1.000	–	–
KOFpolg_df	–0.306	0.194	0.319	0.192	0.067	0.853	1.000	–
KOFpolg_dj	–0.411	0.332	0.639	0.391	–0.123	0.887	0.522	1.000

Note co2ems: growth of CO_2 emissions per capita; in_co2ems: log CO_2 emissions per capita; gdpc: log gross domestic product per capita; lnencon: log energy consumption per capita; tot_nrr: total natural resource rents. KOFpolg_ove: index of political globalization (overall); KOFpolg_df: index of political globalization (de facto); KOFpolg_dj: index of political globalization (de jure).

Table 3
Results of the Random-Effects (RE) Estimations (36 OECD Economies, 1970–2016)

Indicators	(1)	(2)	(3)	(4)	(5)	(6)
Log Initial CO_2 Emissions per Capita	–0.789*** (0.193)	–0.767*** (0.212)	–0.798*** (0.197)	–0.785*** (0.234)	–0.837*** (0.230)	–0.822*** (0.174)
Log GDP per Capita	–0.591*** (0.100)	–0.579*** (0.114)	–0.589*** (0.100)	–0.580*** (0.116)	–0.692*** (0.096)	–0.625*** (0.115)
Log Energy Consumption per Capita	–	–0.042 (0.277)	–	–0.029 (0.294)	–	–
Total Natural Resource Rents	–	–	–0.003 (0.036)	–0.003 (0.038)	–	–
Log Political Globalization (Overall)	–2.409*** (0.649)	–2.400*** (0.652)	–2.398*** (0.649)	–2.386*** (0.661)	–	–
Log Political Globalization (De Facto)	–	–	–	–	–1.784*** (0.445)	–
Log Political Globalization (De Jure)	–	–	–	–	–	–1.338* (0.716)
Constant Term	18.12*** (2.657)	17.98*** (2.564)	18.08*** (2.667)	17.95*** (2.597)	–16.45*** (2.118)	–14.03 (2.685)
Observations	313	313	313	313	313	313
Number of Countries	36	36	36	36	36	36
R-squared (within)	0.182	0.182	0.183	0.183	0.196	0.174
Hausman Test	3.63 [0.21]	3.25 [0.29]	2.96 [0.34]	3.11 [0.32]	2.04 [0.51]	2.27 [0.47]

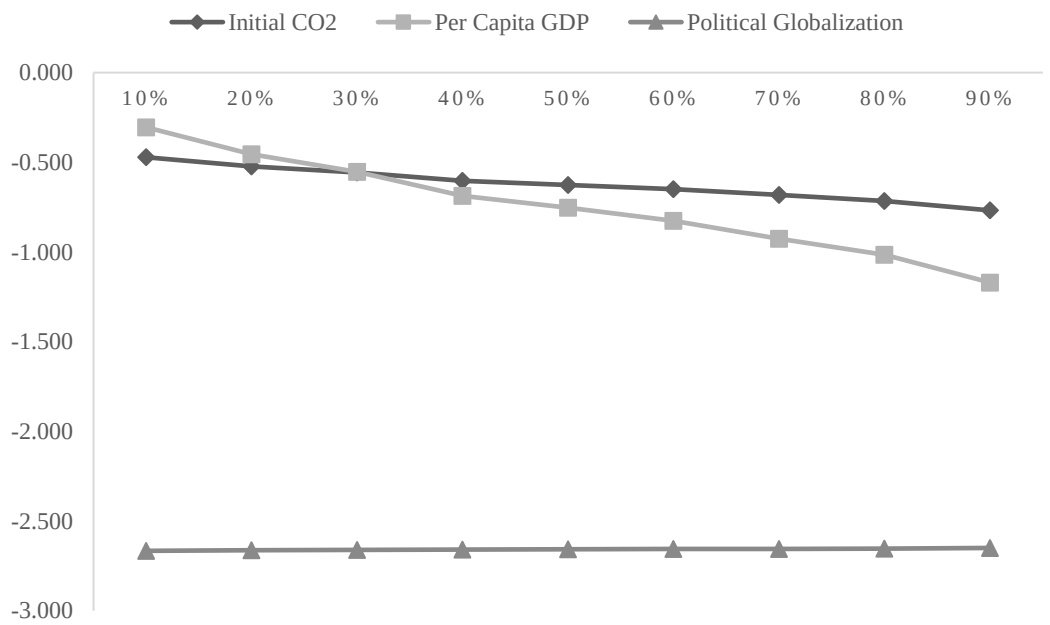
Notes: The dependent variable is growth rate of CO_2 emissions per capita. The robust standard errors are in (). The probability values are in []. *** p<0.01, ** p<0.05, and * p<0.10.

Table 4
Results of PQR-FEMM Estimations (36 OECD Economies, 1970–2016)

Variables & Quantiles:	(10%)	(20%)	(30%)	(40%)	(50%)	(60%)	(70%)	(80%)	(90%)
Log Initial CO_2 Emissions per Capita	–0.472 (0.447)	–0.523 (0.342)	–0.557* (0.287)	–0.603** (0.245)	–0.626** (0.244)	–0.650** (0.259)	–0.681** (0.302)	–0.715** (0.355)	–0.768* (0.465)
Log GDP per Capita	–0.305 (0.385)	–0.455 (0.294)	–0.553** (0.248)	–0.688*** (0.212)	–0.754*** (0.210)	–0.826*** (0.223)	–0.927*** (0.260)	–1.016*** (0.306)	–1.170*** (0.400)
Log Political Globalization (Overall)	–2.666** (1.236)	–2.663*** (0.947)	–2.661*** (0.795)	–2.659*** (0.677)	–2.658*** (0.675)	–2.656*** (0.716)	–2.655*** (0.835)	–2.653*** (0.982)	–2.650** (1.287)
Observations	313	313	313	313	313	313	313	313	313
Number of Countries	36	36	36	36	36	36	36	36	36

Notes: The table represents the results of the PQR-FEMM estimations introduced by Machado and Santos Silva (2019). The dependent variable is the growth rate of CO_2 emissions per capita. The robust standard errors are in (). *** p<0.01, ** p<0.05, and * p<0.10.

Figure 1
Results of the PQR-FEMM Estimations: Coefficients of Each Variable in the Baseline Model at Different Quantiles



Notes: The figure represents the results of the PQR-FEMM estimations introduced by Machado and Santos Silva (2019) for the coefficients of each variable in the baseline model at different quantiles. For details, refer to Table 4.