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The Nexus among Agriculture Sector Development and Environmental Degradation in Emerging Economies

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Abstract
This paper aims to determine the effect of agriculture sector development on CO2 emissions in 10 big emerging market economies. This relationship is tested for the first time for emerging economies by using the panel quantile regression approach. The results suggest that agricultural value-added mitigate emissions in lower, middle-lower, and upper quantile levels. This result implies that the agricultural sector is an effective policy tool in reducing pollution in these countries. Economic growth and natural resources rent have a positive impact on pollution. Financial development only has an emission-reducing effect at the middle-upper quantile level, while globalization has a negative impact on CO2 emissions both in the middle-upper and upper quantiles. These results justify the consideration of heterogeneous effects and allow clear policy implications. Moreover, the critical importance of agricultural policies for environmental quality in these countries is emphasized with concrete evidence.

Keywords:
agriculture, CO_2 emissions, emerging economies, panel quantile approach.

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INTRODUCTION

Today, climate change is one of the most critical environmental, social and economic problems globally. Increased carbon dioxide (CO2) emissions are the primary cause of climate change, and the relationship between CO2 emissions and various economic indicators is widely discussed in the related literature. Although the previous studies mainly focus on the EKC hypothesis, the impact of different indicators on climate change has been handled in many studies over time (Soytas et al., 2007; Jalil & Mahmud, 2009; Esteve & Tamarit, 2012; Tiwari et al., 2013; Alper & Onur, 2016; Jebli et al., 2016; Dogan et al., 2017; Yao et al., 2019; Pata & Aydın, 2020). These are categorized as environmental indicators such as energy (Farhani & Shahbaz, 2014; Gorus & Aslan, 2019; Ardakani & Seyedaliakbar, 2019), natural resources (Balsalobre-Lorente et al., 2018; Danish et al., 2019), economic indicators such as financial development (Shahbaz et al., 2016; Pata, 2018; Nasir et al., 2019), agriculture sector development (Balsalobre-Lorente et al., 2018; Wang et al., 2020), and globalization (You & Lv, 2018; Acheampong et al., 2019; Liu et al., 2020).

Essentially, the EKC hypothesis is based on the view that emissions are rapidly increasing because of a shift from agricultural production to industrial production in an economy with two-sector that has entered a rapid growth process (Cherniwchan, 2012). From a historical perspective, it is known that industrialization processes occur depending on fossil fuel consumption (Gokmenoglu & Taspinar, 2018). It is widely accepted that industrialization has a more significant negative impact on environmental quality in developing countries than in developed countries (Nasrollahi et al., 2020). Nevertheless, the agricultural sector still maintains its importance in economic growth by contributing to an increase in the total factor productivity (Gokmenoglu & Taspinar, 2018). While the agricultural sector contributes directly or indirectly to economic growth, this sector triggers environmental degradation due to intensive energy consumption and land and water use. However, it is still considered how the reducing-effect of CO2 emissions compared to the other sectors, such as the manufacturing and transport sectors (Dogan, 2016; Wang et al., 2020). Besides the theoretical views, there is no consensus on the impact of the agricultural sector on CO2 emissions in the empirical literature. For example, while the Dogan (2016), Mahmood et al. (2019), and Wang et al. (2020) argue that the agriculture sector reduces pollution, Duxbury et al. (1993), Gokmenoglu & Taspinar (2018), Ullah et al. (2018), and Balsalobre-Lorente et al. (2019) achieved the opposite results. According to the OECD (2019) Green Growth Report, emerging market economies have achieved a growth rate that eliminated poverty in the last decade but inevitably caused environmental destruction. It is also envisaged that the environmental destruction is mitigated by measures to improve the agricultural sector in the same report. On the other hand, like the results obtained by Balsalobre-Lorente et al. (2019), the agricultural sector is likely to be an emitter for emerging countries. Therefore, the focus of this study is to reveal the relationship between the agriculture sector development and air pollution in emerging market economies.

Another focus of the study is the consideration of financial development, natural resource rents, and globalization, which are discussed in the current literature regarding their relationship with climate change. Especially in the last two decades, emerging market economies have experienced a significant growth performance, contributing significantly

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to global production and consumption (IMF, 2017). While it is claimed that the most important driving force behind this rapid economic growth is financial development, an inevitable increase in energy demand is expected due to this interaction (Sadorsky, 2010). However, there is no consensus on the studies on the impact of financial development on CO2 emissions. Financial development can be sued to tackle the reduction of CO2 emissions by expanding financing opportunities through banks, and in this case, a positive impact of financial development on environmental quality emerges (Tamazian et al., 2009; Shahbaz et al., 2013a; 2013b; Salahuddin et al., 2015).

On the other hand, financial development can accelerate manufacturing activities and cause an increase in emissions (Al-Mulali & Lee, 2013; Charfeddine & Ben Khediri, 2016; Shahzad et al., 2017). In addition, the impact of the rapid integration of economies with each other because of globalization on environmental performance is another controversial issue. The literature on the impact of globalization on emissions is relatively limited (Liu et al., 2020; Wang et al., 2020). On the other hand, it focuses on trade openness to represent globalization (Shahbaz et al., 2017a; Acheampong et al., 2019; Kim et al., 2019). In this study, it is taken into consideration that the increase in the degree of openness caused by the countries' economic globalization caused the deterioration of the environmental quality (Wang et al., 2020). In addition to all, considering the share of financial development and globalization in economic growth in emerging countries, economic growth and its main dynamics harm environmental quality by increasing natural resource consumption (Danish et al., 2019). Especially the economic growth of resource-rich countries is associated with natural resource extraction that causes environmental degradation (Badeeb et al., 2020).

Although it is possible to come across studies dealing with the relationship between the agriculture sector, growth, financial development, natural resources, globalization, and environmental pollution in the literature, the absence of a study that determines the effects of each variable on emissions in a model creates a gap in the relevant literature. Therefore, the primary priority of the study is to fill this gap. Accordingly, considering the importance of each of these variables for environmental quality and the agricultural sector development in emerging market economies is the novelty of the study. This initiative may be considered a necessity to focus on emerging market economies.

In the light of the explanations mentioned above, this study aims to make various contributions to the literature. First, this paper is the first attempt to investigate the relationship between agriculture sector development and carbon emissions in 10 big emerging market economies. Thus, this study gives an idea about whether these countries, which have undergone rapid industrialization, can gain an advantage in sustainable growth with the development of agriculture. Second, the variables whose impacts on CO2 emissions have been widely discussed recently are considered. This research also considers the importance of emerging markets, besides the freshness of the variables in the related literature. Therefore, while evaluating the agricultural sector development results, the effects of GDP, financial development, natural resources, and globalization on emissions are not neglected, and policy recommendations are discussed in more detail. Third, this paper contributes to the literature methodologically by adopting the panel quantile regression approach. This method is robust to outliers and skewed distributions while it provides the estimation in case of slope heterogeneity.

The rest of the study is structured as follows: Section 2 includes data descriptions, model specifications, and methodological explanations. Section 3 provides empirical results, and the last section is the conclusion.

METHODS

This paper aims to explain the determinants of CO2 emissions by focusing on agriculture sector development in 10 big emerging market economies (Argentina, Brazil, China, India, Indonesia, Mexico, Poland, South Africa, South Korea, and Turkey). For this purpose, the model is constructed by including the widely used variables in recent studies. The following model is developed by Balsalobre-Lorente et al. (2019) and Wang et al. (2020).

$$CO2_{it} = \alpha_0 + \beta_1 AGRI_{it} + \beta_2 GDP_{it} + \beta_3 FIN_{it} + \beta_4 NR_{it} + \beta_5 GLOB_{it} + \varepsilon_{it} \quad (1)$$

Where i and t denotes cross section (10 countries) and the time series (1990-2014), respectively. Each β indicates the slope coefficient of the explanatory variables and ε_{it} implies error correction term. *CO2* stands for CO_2 emissions metric tons per capita; *AGRI* denotes agriculture value added (% of GDP); *GDP* is gross domestic product per capita (constant 2010 US$); *FIN* is used as proxy for financial development and represents the domestic credit to private sector (% of GDP); *NR* denotes total natural resource rents (% of GDP), and finally *GLOB* is economic globalization index. While the economic globalization index is obtained from KOF Swiss Economic Institute, all other variables are provided from the World Development Indicators. The variables are included logarithmically in model.

The stationary of the series is tested in the first stage of the analysis. It is adopted the unit root test developed by Pesaran (2007). The basic equation for this test is as follows:

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} (N,T) \quad (2)$$

The null hypothesis of the test expresses the existence of the unit root. This test is effective in the presence of both slope heterogeneity and cross-sectional dependence. After the stationarity test, panel quantile regression method is used to examine the effect of agriculture sector development, financial development, economic growth, natural resources rents and globalization to CO_2 emissions.

Panel quantile regression approach robust to outliers and skewed distributions, facilities the estimation of slope effects at various percentage points, and allows unobserved heterogeneity. Unlike standard OLS estimators, this method presents a more complete picture of conditional distribution. The panel linear regression Eq. (1) is formulated in matrix notation and quantile regression form as follows:

$$y_{it} = \alpha_i + \beta(q) x'_{it} + u_{it} \quad (3)$$

where i and t stand for the number of countries (10 big emerging countries) and time dimension (1990-2014), respectively. Also, y is dependent variable, x denotes all independent variables, and q implies all quantiles of the conditional distribution. Koenker (2004) estimates the Eq. (1) by solving the minimization problem:

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$$min_{\alpha\beta} \sum_{k=1}^{K} \sum_{t=1}^{T} \sum_{i=1}^{N} w_k \rho_{qk}(y_{it} - \alpha_i - \beta(q_k)x_{it}^{'}) \quad (4)$$

where ρ_{qk}= u(q – I(u<0)) is the piecewise linear quantile loss function provided by Koenker and Bassett (1978). The weights w_k control the relative influence of the τ quantiles (q_1, …, q_τ) on the estimation of the α_i parameters. One of the advantages of this approach is the introduction of a penalty term in minimization to address the computational problem of estimating a mass of parameters specifically (Albulescu et al., 2019). This method, called penalized quantile regression, takes the following form (Koenker, 2004):

$$min_{\alpha\beta} \sum_{k=1}^{K} \sum_{t=1}^{T} \sum_{i=1}^{N} w_k \rho_{qk}(y_{it} - \alpha_i - \beta(q_k)x_{it}') + \lambda P(\alpha) \quad (5)$$

Where $p(\alpha) = \sum_{i=1}^{N} |\alpha_i|$ is the penalty considered. Also, i denotes each country, T is the index for number of observations per countries, K implies quantiles, x stands for the matrix of explanatory variables, ρ_{qk} is the quantile loss function.

RESULT AND DISCUSSIONS

This study analyzes agriculture sector development, economic growth, financial development, natural resources, and globalization on CO2 emissions. For this purpose, a panel dataset was collected for ten big emerging market economies covering the 1990-2014 data period. Table 1 presents the summary statistics of all variables. As seen in Table 1, the skewness results are different from 0 for all variables except the AGRI, indicating that variables are asymmetric. Also, the data have fatter tails because most positive kurtosis values are higher than 3. Jarque-Bera results, which give information about the normal distribution, show that all series depart from normal distribution except the FIN. In the light of the results obtained from the series, it can be mentioned that there is heterogeneity, and thus the use of the quantile regression method is appropriate.

Table 1. Descriptive Statistics

Variable	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Obs.
CO2	0.559	0.589	0.327	-0.292	2.009	0.001	250
AGRI	0.819	0.777	0.337	0.016	2.145	0.000	250
GDP	3.744	3.889	0.385	-0.968	3.010	0.022	250
FIN	1.601	1.557	0.349	-0.117	3.325	0.433	250
NR	0.211	0.442	0.727	-1.495	4.456	0.000	250
GLOB	1.623	1.651	0.122	-1.032	4.227	0.000	250

The CIPS panel unit root test, which considers heterogeneity, is applied in this study. This approach has tested the hypothesis that expresses the existence of unit root. Results are illustrated in Table 2. The unit root test for the series is calculated for all deterministic components for the robustness of the results. The results prove that all series are I(1). However, it is understood that the CO2 in the model with intercept, GDP and NR in the model with trend and intercept, and AGRI in the model without trend and intercept are I(0).

Table 2. Unit root test results

	Intercept		Trend and Intercept		None	
Variable	**Level**	**1st Diff.**	**Level**	**1st Diff.**	**Level**	**1st Diff.**
CO2	-2.309*	-5.100***	-2.057	-5.177***	-0.806	-5.085***
AGRI	-2.020	-5.825***	-2.086	-5.925***	-1.649*	-5.792***
GDP	-1.890	-4.943***	-2.775*	-5.518***	-1.337	-5.332***
FIN	-0.665	-4.990***	-1.634	-5.129***	-0.827	-5.067***
NR	-2.005	-5.573***	-3.025**	-5.701***	-0.295	-5.567***
GLOB	-2.122	-5.207***	-2.399	-5.128***	-1.286	-5.236***

*, ** and *** denotes 10%, 5% and 1% statistically significance level, respectively.

Table 3 includes the OLS results with fixed effects and the quantile regression results. Random effects estimation results suggest that agriculture value-added has a negative impact on CO2 emissions. However, economic growth causes environmental degradation. Other explanatory variables have a statistically insignificant effect on pollution. OLS approaches are not robust as they only give estimates regarding the conditional mean. Therefore, the main focus of the study is panel quantile regression results in five quantiles (0.10, 0.25, 0.50, 0.75, 0.90). These quantiles are categorized as lower quantile (0.10), middle-lower quantile (0.25), middle quantile (0.50), middle-upper quantile (0.75), and upper quantile (0.90). Therefore, the heterogeneous effects of all explanatory variables on pollution are clearly presented. First, while the agricultural sector development is negative at all quantile levels, it is observed that the coefficient of this variable is statistically significant at lower, middle-lower, and upper quantile levels. This result is like Balsalobre-Lorente et al. (2019), Dogan (2016), and Mahmood et al. (2019), but is the opposite of Ullah et al. (2018), Gokmenoglu & Taspinar (2018), Dogan (2019), and Wang et al. (2020). Second, an increase in GDP per capita, which is used as an indicator of economic growth, causes pollution in all quantiles up to the upper quantile level (As seen in Shahbaz et al., 2013a). However, this positive effect decreases as the quantile level increases. Third, financial development only has an emission-reducing effect in the middle-upper quantile level (As seen in Shahbaz et al., 2013a; 2013b), while globalization has a negative impact on CO2 emissions both in the middle-upper and upper quantiles (As seen in Shahbaz et al., 2017b; Zaidi et al., 2019). Finally, the natural resource rents' coefficients are positive and statistically significant in all quantiles. This finding is in line with Hassan et al. (2018), Khan et al. (2020), and Balsalobre-Lorente et al. (2018).

First, the results confirmed that these countries would successfully combat climate change by providing added value to agriculture. This result is observed, especially for countries where carbon emissions are relatively lower (0.10 and 0.25 quantiles) or relatively upper (0.90 quantiles). Therefore, while climate change is a disadvantage for the agricultural sector, the steps to create agricultural value-added are a remedy for this negative impact. However, contrary to the expectations, it is interesting that economic globalization contributes to environmental quality in these countries. Accordingly, the existence of economic globalization compels countries to follow international environmental developments.

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Table 3. Panel quantile regression results (dep. var.: CO2)

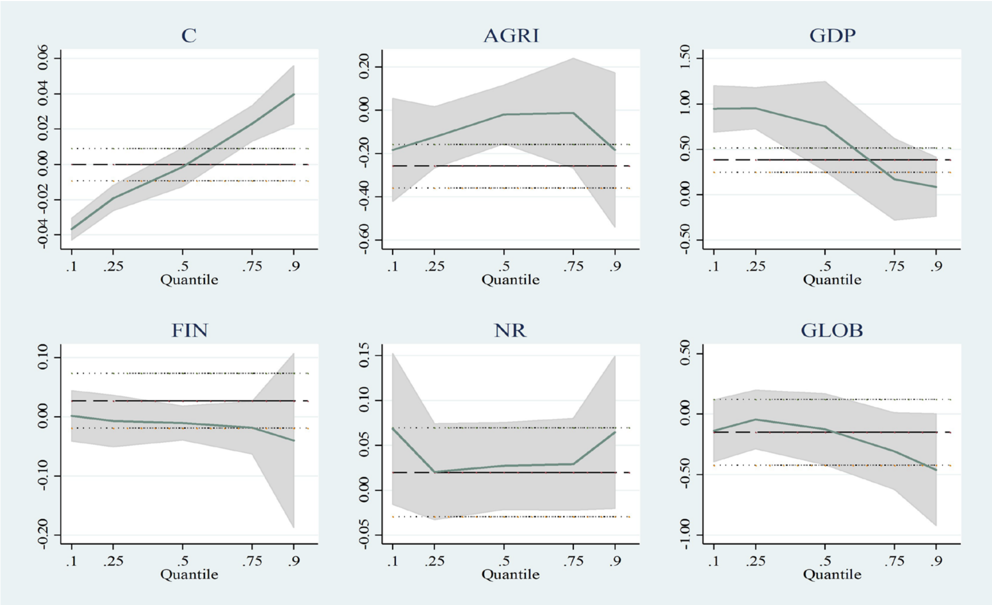
	OLS	QUANTILE REGRESSION				
Variable	Random Effects	0.10	0.25	0.50	0.75	0.90
AGRI	-0.257***	-0.183***	-0.123***	-0.018	-0.012	-0.182***
GDP	0.384***	0.947***	0.953***	0.755***	0.171***	0.087
FIN	0.027	0.001	-0.006	-0.010	-0.018*	-0.039
NR	0.020	0.068***	0.020*	0.027*	0.028***	0.064**
GLOB	-0.152	-0.140	-0.044	-0.125	-0.307***	-0.461***
CONS.	-0.000	-0.036***	-0.019***	-0.001	0.023***	0.039***

*, ** and *** denotes 10%, 5% and 1% statistically significance level, respectively.

Contrary to these results, economic growth and natural resource rents cause pollution at all quantile levels. Thus, it is confirmed that the ten big emerging countries that experienced rapid economic growth during the period under consideration inevitably faced pollution costs. In addition, although the resource rents are an essential revenue source for these countries, the environmental damage caused by the extraction of natural resources is felt more intensely. Finally, the results from financial development evoke a negative effect, albeit slightly. Therefore, it would be more appropriate for these countries to concentrate on other variables.

It is presented the changes in panel quantile regression coefficients in Figure 1. The x-axis implies the conditional quantiles of CO2 emission, and the y-axis expresses the coefficient values of the explanatory variables. The shaded areas denote the 95% confidence intervals of the estimations. This figure is an intuitive presentation of the changes in the coefficients of the explanatory variables whose effects are tested. The trends of these coefficients confirm the results obtained from the quantile regression.

Figure 1. Trends of Quantile Regression Estimates



CONCLUSION

This paper analyzes the nexus among CO2 emissions, agriculture sector development, financial development, economic growth, natural resources, and globalization in the top 10 emerging market economies using a panel quantile regression approach. Empirical results indicate that agriculture value-added has a negative impact on CO2 emissions in lower quantile, middle-lower quantile, and upper quantile levels. GDP and natural resources rents have a positive impact on pollution. Although this effect of natural resources rents increases gradually, it is very slight. Globalization contributes to environmental quality in middle-upper and upper quantiles. Finally, financial development has a negative impact on emissions in only the middle-upper quantile level. This study, which focuses on the function of the agriculture sector in combating climate change, also leads to important policy implications because of the explanatory variables selected by considering the structural features of these emerging countries with different levels of CO2 emissions.

Countries with lower, middle-lower and upper pollution levels should prioritize agriculture sector development and ensure this development by considering environmental quality as far as possible. The increase in agricultural value-added, which is considered the agriculture sector development, is inevitably linked to technological developments. Therefore, producing value-added in the agriculture sector is intertwined with technology, also called digital agriculture. Digital agriculture contributes to agricultural development mainly by providing fast and reliable results in efficient fertilization (according to the climate, soil structure, and agricultural product planned to be produced) and soil analysis. In this way, products with high value-added can be produced without risk. These countries can contribute to agricultural value-added and environmental quality through digitalization in agriculture. Therefore, technology support for the agricultural producer and the R&D investments and incentives of governments in this field is an essential tools. It is also beneficial for the agricultural producer to use technology and to be regularly directed towards the correct production and management techniques. However, all these digital trends should be realized by considering the environmental quality because modern production techniques are likely to impair air quality. Green transformation of agricultural technologies that require fuel should be ensured to prevent pollution. At the same time, carbon emissions should be prevented by crop rotation. In other words, given the technology factor, instead of accepting the agriculture sector as an alternative to the manufacturing sector, they should complement each other to ensure environmental quality.

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