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Do Diversified Export, Agriculture, and Cleaner Energy Consumption Induce Atmospheric Pollution in Asia? Application of Method of Moments Quantile Regression

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Sustainable development remains unattainable unless we move to reduce the negative impact of economic factors on environmental quality. It is noteworthy to provide new evidence on whether and how the empirical association between export diversification, agricultural value-addition, renewable energy, and regulatory quality with greenhouse gas (GHG) emissions evolved in Asian countries from 1996 to 2014. The study examines the relationships between these variables using current panel data techniques. The econometric procedure includes second-generation cointegration and unit root tests together with a novel Method of Movements Quantile Regression (MMQR). This approach offers an asymmetric relationship between the variables and is very robust to outliers compared to traditional quantile regression. The empirical outcomes show that export diversification, renewable energy, and regulatory quality are significantly and negatively associated with GHG emissions. In contrast, agricultural value-added in Asia has become a source of increased GHG emissions. Our findings are also robust with alternate specifications, including fully modified, dynamic and fixed effect regressions. This study will help policymakers for diversifying their export portfolio while ensuring a sustainable environment in Asia.

Keywords: GHG emissions, export diversification, agriculture, renewable energy, regulatory quality, MMQR, Asia

INTRODUCTION

Gradually changing climate and ongoing environmental degradation are the most obvious challenges facing the entire world today. Greenhouse gas (GHG) emissions are expected to reach 416 ppm by the end of 2021, bestowing the highest level in history (MBE, 2021). This huge increase in GHG has a negative impact on the sustainable future of humanity in terms of economy and health. Therefore, both developed and developing nations prioritize environmental protection and energy security to accomplish the 2030 Sustainable Development Goals (Merchant, 2016; Sharma R. et al., 2021). Governments care about international trade by making economic gains after satisfying social and

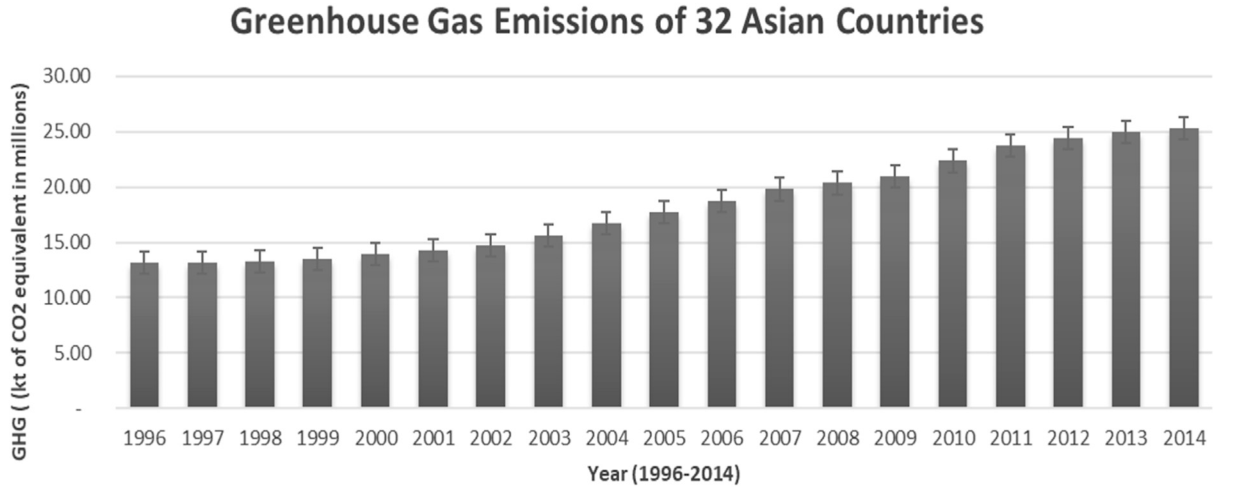

FIGURE 1 | Annual total GHG emissions.

non-social interest groups. However, economies based on the export of a specific and dirty commodity cause significant environmental pollution. To curtail dependence on specific exports and to achieve sustainable earnings, the World Bank (2021) and International Monitoring Fund (IMF) encourage countries to diversify their exports.

Not only have that, but this study also instigate export diversification is inevitable for the economy for several reasons. First, diversified exports refer to the process by which the risk of international trade can be minimized (Bertinelli et al., 2006). Second, it has a positive impact on economic growth (Grossman and Helpman, 1991). Third, it permits economies to have a stabilized balance of payments and helps to prevent trade shocks (McIntyre et al., 2018). Due to a sufficient number of resources, export diversification is characterized as a phenomenon that is considered an essential part of structural change and development (Ali, 2017; Goya, 2014) and seems to affect the environmental quality (Jebli et al., 2016).

It is not unusual for there to be a reciprocal association between agriculture and the environment. On the one hand, a considerable amount of GHG emissions is produced by agricultural production based on traditional and outdated practices (Frank et al., 2017; Zurek et al., 2020; Pata, 2021a). On the other hand, agriculture is highly dependent on the environment for water, genetic material and land, although it seems to lead to environmental degradation. Intergovernmental Panel on Climate Change (IPCC) disclosed that from 2007 to 2016, the use of land and agriculture was responsible for almost 23% of GHG emissions. In this sense, IPCC predicts ~21–37% GHG emissions by 2050 (Sharma R. et al., 2021). These consequences draw new avenues to raise questions:

1) Whether and how is export diversification seen to promote a sustainable environment?
2) Do agricultural value addition, renewable energy, and regulatory quality influence environmental quality?

Asia is presumed a potential region to address the above queries. First, in terms of the developing countries, Asia is a hub of the fastest emerging nations, such as China, which is the diversified and largest exporter in the world. Second, Asia is the most populous region in the world and is home to more than half of human beings (Asian Development Bank, 2017). Not only that, meeting the agricultural (farming and food) needs of the people remains a vulnerable challenge for this region. Third, Asia is the most critical part of climate change. Over the last decade, this region has been the largest emitter of GHG in the world (Le et al., 2020). Lastly, 93 of the 100 most populous cities in the world are located in Asia (IRENA, 2018). This region has remarkable potential for switching to renewable energy sources (Zafar et al., 2021). Therefore, it is crucial to objectively evaluate Asian nations by discovering the impact of renewable energy on GHG emissions to identify the potential for economic and environmental gains. **Figure 1** exhibits the GHG emissions of 32 Asian countries from 1996 to 2014, illustrating that emissions are perpetually growing and have almost doubled in 2 decades.

Existing literature has scrutinized the links between export diversification, agricultural value-addition, renewable energy, and regulatory quality with carbon dioxide (CO_2) emissions on a piecemeal basis, which left several margins our research addresses. To the best of our knowledge, this study contributes to the current literature in several ways. First, this study observes the influence of a unique combination of variables including export diversification, agricultural value addition, renewable energy and regulatory quality on GHG emissions in 32 emerging Asian economies. Second, this study employed a novel panel data estimator, Method of Movements Quantile Regression (MMQR), which Machado and Silva (2019) recently proposed. This method deals well with the outliers and provides estimations at location, scales and quantiles.

Third, this study provides robust findings with alternative methods including fully modified, dynamic and fixed effect (FMOLS, DOLS & FE) estimators. Finally, this study provides non-linear associations among variables through quantile distributions.

The rest of the sections of this study are arranged as follows; *Literature Review* explains the review of the existing literature, while *Data methodology* narrates the data and methodology. *Empirical Results* interprets and enumerates the findings, while *Conlcusion* concludes the study and reports policy implications.

LITERATURE REVIEW

Over the last 2 decades, there has been much discussion about the possible determinants of environmental degradation. In this regard, various researchers have thoroughly investigated the potential reasons for the increase in GHG emissions employing different model specifications. To consider the extent of the linkages between export diversification, agriculture, renewable energy consumption, regulatory quality and environmental quality, we discuss the following recent literature.

The nexus between export diversification and environmental quality has recently been explored in the literature. For instance, Shahzad et al. (2020) scrutinized the impact of product diversification and intensive margin on CO_2 emissions for panel data of 63 developing and developed economics from 1971 to 2014. The study results presented the negative influence of diversification on the environment. Hu et al. (2020) examined panel data of both 93 developing and 35 developed nations by employing augmented mean group (AMG) and common correlated effect mean group (CCEMG) techniques. They established a negative influence of product diversification on CO_2 emissions for developed nations while positively contributing to developing countries. Li et al. (2021) applied a novel statistical technique and found that export diversification mitigates CO_2 emissions from 1989 to 2019 in China. In the case of BRICS countries, Sharma R. et al. (2021) reported the favorable interconnection of export diversification with air quality. Then, Wang et al. (2021) analyzed the role of export product quality on CO_2 emissions in the ten largest economies by using DOLS and FMOLS. They found a negative and significant association between export product quality and the environment. Similarly, Fareed et al. (2021) studied the influence of export diversification and renewable energy on load capacity factor using a Fourier quantile causality technique in Indonesian from 1965Q1 to 2014Q4. They concluded that export diversification and renewable energy consumption are significantly increased load capacity factor and thus improved environmental quality in Indonesia.

The literature mainly talks about the negative relationship between export diversification and environmental pollution. On occasions, however, export diversification is positively linked with the environment. For instance, Mania (2020) noted that export diversification has a positive and significant influence on the environment. Moreover, Wang et al. (2020) observed the linkage of ecological innovation and export diversification with the environment from 1900 to 2017 for G-7 countries. Their results show that export diversification refers to the process by which the intensity of CO_2 emissions increases.

In the case of agriculture and the environment, it is necessary to evaluate the connection of farming with the atmosphere from both perspectives. For instance, agriculture based solely on non-renewable energy, biomass burning and fertilizer use are considered as significant contributors to the rising GHG emissions (Qiao et al., 2019). Ismael et al. (2018) concluded that agricultural activities are positively linked with CO_2 emissions in Jordan. Appiah et al. (2018) examined the causal connection between agriculture (livestock and crop production) and carbon emissions by applying FMOLS and DOLS in BRICS countries for panel data from 1973 to 2013. Their inclusive outcomes suggest that agriculture appears to lead to environmental degradation.

Similarly, Pata (2021a) used Fourier ARDL cointegration and Fourier causality test for BRIC countries from 1971 to 2016 and concluded that agriculture increases CO_2 emissions in China. Besides, Sharma G. D. et al. (2021) probed the agriculture value-added and renewable energy consumption with GHG emissions in countries of The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation. They found a U-shaped connection between agriculture and GHG emissions. Contrary to general opinion, Aziz et al. (2020) reported that agriculture reduces pollution in Pakistan.

The interconnection between renewable energy consumption and greenhouse gas emissions can be discussed under the following two segments. Firstly, there is a plethora of research reporting a negative association between renewable energy and GHG emissions. For example, Bilgili et al. (2016) utilized panel FMOLS and DOLS estimators for 17 OECD countries from 1977 to 2010 and noted that renewable energy reduces CO_2 emissions. Fuinhas et al. (2017) studied the association of renewable energy and carbon emissions by employing panel estimations for Latin American countries. They suggested that renewable energy sources are helpful in reducing CO_2 emissions. The impact of renewable and non-renewable energy on the environment was investigated on panel data of 19 economies from 1990 to 2014 in Africa. In addition, Akram et al. (2020) examined the influence of energy efficiency and renewable energy consumption on CO_2 emissions by using hidden panel cointegration and non-linear ARDL approaches for BRICS countries from 1990 to 2014. They suggested that positive shocks in energy efficiency and renewable energy consumption significantly decrease carbon emissions in the long run. Nathaniel and Iheonu (2019) concluded that renewable energy is negatively while non-renewable energy is positively associated with the environment. Similarly, Isik et al. (2020) found that renewable energy has a negative impact on CO_2 emissions in France. In addition, Pata (2021b) confirmed the reducing role of renewable energy on CO_2 emissions in the United States. However, secondly, some studies have found no association between renewable energy and CO_2 emissions. According to the study of Al-Mulali et al. (2015), renewable energy has no significant effect on CO_2 emissions in Vietnam. Pata (2018) concluded that renewable and clean energy forms are not adequately used to reduce CO_2 emissions in Turkey. Using

TABLE 1 | Variables of the study.

Symbol	Description	Measurement unit	Source
GHG	Green House Gases	Total greenhouse gas emissions (kt of CO_2 equivalent)	WDI
ED	Export Diversification	Overall exports changes (change in new and existing products)	IMF
AGRI	Agriculture	Agriculture, forestry, and fishing, value added (% of GDP)	WDI
REC	Renewable Energy	Renewable energy use (% of total energy)	WDI
RQ	Regulatory Quality	One of six broad dimensions of governance (Index 0–100)	WGI

WDI, IMF and WGI stand for World Development Indicators (World Bank, 2021), International Monetary Fund (2021) and Worldwide Governance Indicators (2021), respectively.

the augmented ARDL method, Pata and Caglar (2021) emphasized that renewable energy does not help to minimize environmental pollution in China.

A few studies have shed light on the impact of regulatory quality on the environment. This study is motivated by Gungor et al. (2021) in the direction that regulatory quality exerts a negative and significant association with the environment in South Africa. Similarly, Adedoyin et al. (2020) utilized balanced panel data from 1990 to 2014 and reported that regulatory quality plays a role in preventing environmental erosion. In contrast, Ibrahim and Ajide (2021) examined environmental quality using BRICS nations ranging from 1996 to 2018 and clarified that regulatory quality and financial development escalate CO_2 emissions.

In conclusion, the above discussion has shown that the existing literature has not clarified and conclude the true relationship between export diversification, agriculture, renewable energy, regulatory quality and environmental pollution in developed and emerging economies worldwide.

DATA AND METHODOLOGY

Data and Model

To accomplish the objective of the study, we investigated the impact of export diversification, agricultural value-addition, renewable energy consumption and regulatory quality on GHG emissions using an annual balanced panel data of 32 Asian economies from 1996 to 2014. The list of selected Asian countries can be found in **Appendix A**. The description, unit of measurement and data sources are reported in **Table 1**.

The annual data of GHG emissions (kt of CO_2 equivalent), agriculture value-added (% of GDP) and renewable energy use (% of total energy) is compiled from WDI. In contrast, data on export diversification (overall exports changes) is collected from the IMF. The annual data of regulatory quality (governance dimension) is gathered from WGI. Based on the existing literature, we analyze the following model.

$$ln\,\mathrm{GHG_{it}} = \beta_O + \beta_1\, ln\,\mathrm{ED_{it}} + \beta_2\, ln\,\mathrm{AGRI_{it}} + \beta_3\, ln\,\mathrm{REC_{it}} + \beta_4\, ln\,\mathrm{RQ_{it}} + \varepsilon_t. \quad (1)$$

Panel Estimation Techniques

To make a comparison, we employ FMOLS, DOLS and FE estimators. The FE technique is upgraded with Driscoll and Kraay standard errors (Driscoll and Kraay, 1998), and is robust to general forms of autocorrelation, cross-sectional dependence and heterogeneity up to certain lags (Le et al., 2020; Pedroni, 2004). The FMOLS is efficient enough to overcome heterogeneity problems with variations in the means (Pedroni, 2004). DOLS is found to be unbiased compared to FMOLS and FE in an infinite sample size. Using Monti Carlo simulations, Kao and Chiang (1999) extended the DOLS estimator to panel data settings. DOLS can handle endogeneity problems through the augmentation of lagged and leading differences.

A panel quantile regression is a better alternative to overcome the issues of previous techniques and examine the heterogeneous and distributional effects across various quantiles (Sarkodie and Strezov, 2019). The panel quantile regression was initially proposed by Koenker and Bassett (1978), and is used to estimate the dependent conditional mean and variance with respect to the explanatory parameters. However, to meet the objective of this study, we employed the Method of Moments Quantile Regression with the fixed effects method proposed by Machado and Silva (2019). MMQR, whilst robust to outliers and within panels, do not assume unobserved heterogeneity (Ike et al., 2020). This technique is efficient enough to account for the covariance effect of conditional heterogeneity in the determinants of GHG emissions. Rather than just shifting the means, it allows individual effects to affect the whole distribution (Koenker, 2004). The estimate of the conditional quantiles Qy $(\tau|\mathcal{Z})$ for a location-scale model variant is explained in the following form.

$$\ddot{\mathrm{U}}_{it} = \alpha_i + \mathcal{Z}_{it}\,\beta + (\delta_i + \Phi_{it}\,\Upsilon)\,U_{it}, \quad (2)$$

where the probability is $P\{\delta_I + \Phi_{it}\Upsilon > 0\} = 1$ and $(\alpha, \beta', \delta, \Upsilon')'$ are the parameters to be estimated. (αi, δi), $i = 1, \ldots, n$, designates that Φ is a k-vector of recognized elements and the discrete fixed effects of the individual i of Ƶ which is a differentiable transformation with component l known by:

$$\Phi_l = \Phi_l(\mathcal{Z}), l = 1, \ldots, k, \quad (3)$$

$\mathcal{Z}_{it}$ is identically and independently distributed for independent across time t and cross-section i. Similarly, U_{it} distributed across fixed cross-sections i and time t are orthogonal to $\mathcal{Z}_{it}$ (Machado and Silva, 2019), which, amongst other things, do not provide strict exogeneity. **Equation 2** implies the following.

$$Q_y(\tau|\mathcal{Z}_{it}) = (\alpha_i + \delta_i q(\tau)) + \mathcal{Z}_{it}\beta + \Phi_{it}\Upsilon q(\tau). \quad (4)$$

In **Equation 4**, $\mathcal{Z}_{it}$ is a vector of regressors, for instance, export diversification is taken in logarithm form (lnED).

TABLE 2 | Statistics description.

Variables	GHG	ED	AGRI	REC	RQ
Obs.	608	608	608	608	608
Mean	570327.700	3.224	12.067	21.263	48.599
Minimum	5,650.000	1.759	0.033	0.006	0.513
Maximum	11900000.000	6.417	46.318	91.515	100.000
Std. Dev.	1449810.000	1.154	9.845	24.653	22.630
Skewness	5.178	1.001	1.004	1.150	0.169
Kurtosis	33.796	3.144	3.466	3.285	2.554

Source: Authors' calculation (without logarithm values)

$Q_y(\tau|\mathcal{Z})$ denotes the quantile distribution of the dependent variable $\ddot{U}_{it}$ (logarithm of GHG emissions), which is presented as conditional on the location of the independent variable and $\mathcal{Z}_{it} - \alpha i(\tau) \equiv \alpha i + \delta_i q(\tau)$ is clarified as a scaler coefficient, indicating the fixed effect quantile τ for an individual cross-section *i*. However, the individual effect does not denote the intercept shift, unlike the least squares fixed effects. Such parameters are time-invariant, whose heterogeneous effects can change (endogenously) across the quantiles of the conditional distribution of the variable Ü (endogenous). $q(\tau)$ demonstrates the $\tau - th$ sample quantile estimated by solving the resulting optimization problem.

EMPIRICAL RESULTS

In this section, we explain and discuss the findings. **Table 2** presents the summary statistics (i.e., mean, minimum, maximum, standard deviation, skewness, and kurtosis) of the selected variables. The mean value of GHG emissions is 570,328 (kt of CO_2 equivalent), while the mean values for export diversification, agriculture, renewable energy and regulatory authority are 3.22, 12.07, 21.26 and 48.60, respectively. GHG emissions have the highest standard deviation (1,448,810), whereas ED has the lowest (1.154). Furthermore, **Table 2** clarifies that the skewness is positive for all factors in the study.

To assess the existence of cross-sectional dependence (CSD) among 32 Asian countries, we utilize the CSD test proposed by Pesaran (2004). This CDS test is efficient enough to distort the true parameters of the coefficient estimates. Due to unobserved common factors, the CSD test can eliminate the efficiency gains of panel data (Phillips and Sul, 2003). **Table 3** explains the presence of CSD in two variables, including GHG emissions and agricultural value-added, while the remaining three variables show no CSD. The presence of CSD implies that the first generation unit root tests is inadequate and suggest the application of second-generation unit root tests. Therefore, to address this issue and obtain robust coefficient estimates, we employ the Cross-sectional Augmented Dickey-Fuller (CADF) test of Pesaran (2007).

The findings of **Table 3** clarify that all variables are stationary at the first difference. Therefore, in the next step, we examine the cointegration relationship between the variables and report the results in **Table 4**.

In order to ascertain the presence of non-spurious long-run cointegration among the variables, we employ Kao and Westerlund's panel cointegration tests and Westerlund (2007) bootstrap panel cointegration approach. Based on Engle and Granger (1987) methodology, Kao and Westerlund's cointegration tests provide a compendium framework for panel cointegration testing. **Table 4** elucidates that the null hypothesis of no cointegration is rejected in Panel (a), as six different test statistics and their probability values prove the existence of long-run cointegration. In addition, Panel (b) reports that four additional tests are proposed with the null of no-cointegration following the Westerlund bootstrap technique. These tests relax the compulsion of common factor restrictions on residual dynamics (Kremers et al., 1992). Using the Westerlund bootstrap approach, we can obtain robust critical findings by minimizing the biasing effects of the CSD. From the second-generation panel cointegration approach in Panel b, we find that four tests, including Gτ, Gα, Pτ and Pα are significant at the 1% level and support the robustness of the long-run cointegration. After determining the cointegration relationship, we perform elasticity calculations and summarize the results of mean based-estimators in **Table 5**.

The results draw a comparison among panel estimation procedures, e.g., FMOLS, DOLS and FE for Asian countries. Obviously, the coefficients resulting from these specifications, although significant at different levels, are closer to each other. The findings show that export diversification negatively and significantly affects GHG emissions. A 1% improvement in export diversification mitigates GHG emissions by −0.70%, −1.68% and −2.46% in the case of FMOLS, DOLS and FE, respectively. These empirical results are corroborated with the findings of Li et al. (2021), Shahzad et al. (2020)

TABLE 3 | Results of CSD and CADF unit root test.

Variable	CSD	*p-value*	CADF results			
			I(0)		*I(I)*	
			C	C + T	C	C + T
lnGHG	25.031	0.000	−1.68	−1.81	−2.39***	−2.77***
lnED	0.780	0.435	−1.64	−2.24	−2.94***	−2.96***
lnAGRI	5.129	0.000	−2.18**	−2.32	−2.89***	−3.04***
lnREC	−0.082	0.934	−0.66	−2.18	−2.72***	−2.92***
lnRQ	1.106	0.269	−1.74	−1.86	−2.95***	−3.15***

*C and C + T stand for constant and constant + trend, respectively. *, **, *** demonstrate significance level at 10; 5 and 1%, respectively.*

TABLE 4 | Panel cointegration tests for Asian countries.

Panel (a) Kao and Westerlund panel cointegration tests	Statistics	Prob.
Model: lnGHG = *f*(lnED + lnAGRI + lnREC + lnRQ)		
Kao panel cointegration test		
Modified Dickey-Fuller	2.156	0.016
Dickey-Fuller	1.912	0.028
Augmented Dickey-Fuller	1.589	0.056
Unadjusted modified Dickey-Fuller	2.097	0.018
Unadjusted Dickey-Fuller	1.849	0.032
Westerlund panel cointegration test		
Variance ratio	2.131	0.017

Panel (b) Westerlund bootstrap panel cointegration

Statistics	Value	Z-value	*p*-value	Robust *p*-value
Gτ	−8.785	−12.895	0.000	0.000
Gα	−13.209	−9.094	0.000	0.000
Pτ	−9.231	−11.427	0.000	0.000
Pα	−7.016	−8.121	0.000	0.000

Source: Authors Calculation

TABLE 5 | Panel estimation estimations.

Variable	FMOLS	DOLS	FE
lnED	−0.700**	−1.680**	−2.462***
lnAGRI	0.200***	0.090***	0.204***
lnREC	−0.530*	−0.160*	−0.332***
lnRQ	−0.170**	−1.090***	−0.759***

*Source: Authors' estimation. *, **, *** demonstrate significance level at 10; 5 and 1%, respectively.*

and Wang et al. (2021), but contradict Mania (2020) and Wang et al. (2020). Agricultural value-added is the most significant variable in all estimates. A percentage rise in agricultural value-added positively influences GHG emissions by 0.20% for both FMOLS and FE, while 0.09% for DOLS. These findings are similar to those of Qiao et al. (2019) and Sharma R. et al. (2021) while opposite to Aziz et al. (2020).

Moreover, renewable energy consumption shows a negatively significant interconnection with GHG emissions for all three specifications. A 1% change in REC brings variations in GHG emissions by −0.53% in the case of FMOLS, while it is −0.16% and −0.33% in the case of DOLS and FE, respectively. The findings are in line with Fuinhas et al. (2017), Nathaniel and Iheonu (2019), and Pata (2021b). In addition, the regulatory authority reports an indirect relationship with GHG emissions. From the table, it can be seen that a 1% change in the regulatory quality preserve the environment between −1.09% and −0.17% for all three specifications. This finding is consistent with Adedoyin et al. (2020) and Gungor et al. (2021).

The outcomes of the MMQR approach presented in **Table 6** assess the relationship of export diversification, agriculture, renewable energy and regulatory quality with GHG emissions in 32 Asian countries. A negative and significant influence of export diversification on emissions can be observed across all quantiles (except for the 10th quantile). When the heterogeneous coefficients of export diversification increase through the 10th to 90th quantiles, the intensity of GHG emissions decreases from −0.03 to −5.12. A point that emerges from the findings is that more ED appears to lead to a favorable direction by preserving the environment (Shahzad et al., 2020; Li et al., 2021; Wang et al., 2021). In the case of agriculture, the results exert statistically significant and heterogeneous coefficients among quantiles. The positive coefficients clarify that the linkage of agriculture to GHG emissions increases as we move from the lower to the upper quantiles. A 1% increase in agriculture implies a 0.18–0.35% increase in GHG emissions. At the highest quantile, the coefficient value of agriculture is the utmost, demonstrating that the environment deteriorates as agriculture moves from the 10th to the 90th quantile. The findings are consistent with those of Qiao et al. (2019) and Sharma R. et al. (2021).

However, the use of renewable energy has vigorously contributed to diminishing the opposing effects on society and the environment by providing solutions to fulfil the Sustainable Development Goals. In

TABLE 6 | Panel quantile estimation-MMQR.

Variable	Location	Scale	Quantiles								
			10th	20th	30th	40th	50th	60th	70th	80th	90th
lnED	−2.605***	−1.548***	-0.034	−0.629*	−1.679***	−2.459***	−2.916***	−3.248***	−3.699***	−4.343***	−5.117***
lnAGRI	0.264***	0.051	0.179**	0.198**	0.233***	0.259***	0.274***	0.285***	0.300***	0.322***	0.347***
lnREC	−0.363***	−0.048**	−0.283***	−0.302***	−0.334***	−0.358***	−0.372***	−0.382***	−0.396***	−0.416***	−0.440***
lnRQ	−0.801***	−0.343***	−0.231	−0.362**	−0.595***	−0.768***	−0.869***	−0.943***	−1.043***	−1.186***	−1.357***

*Authors' estimation. *, **, *** demonstrate significance level at 10; 5 and 1%, respectively.*

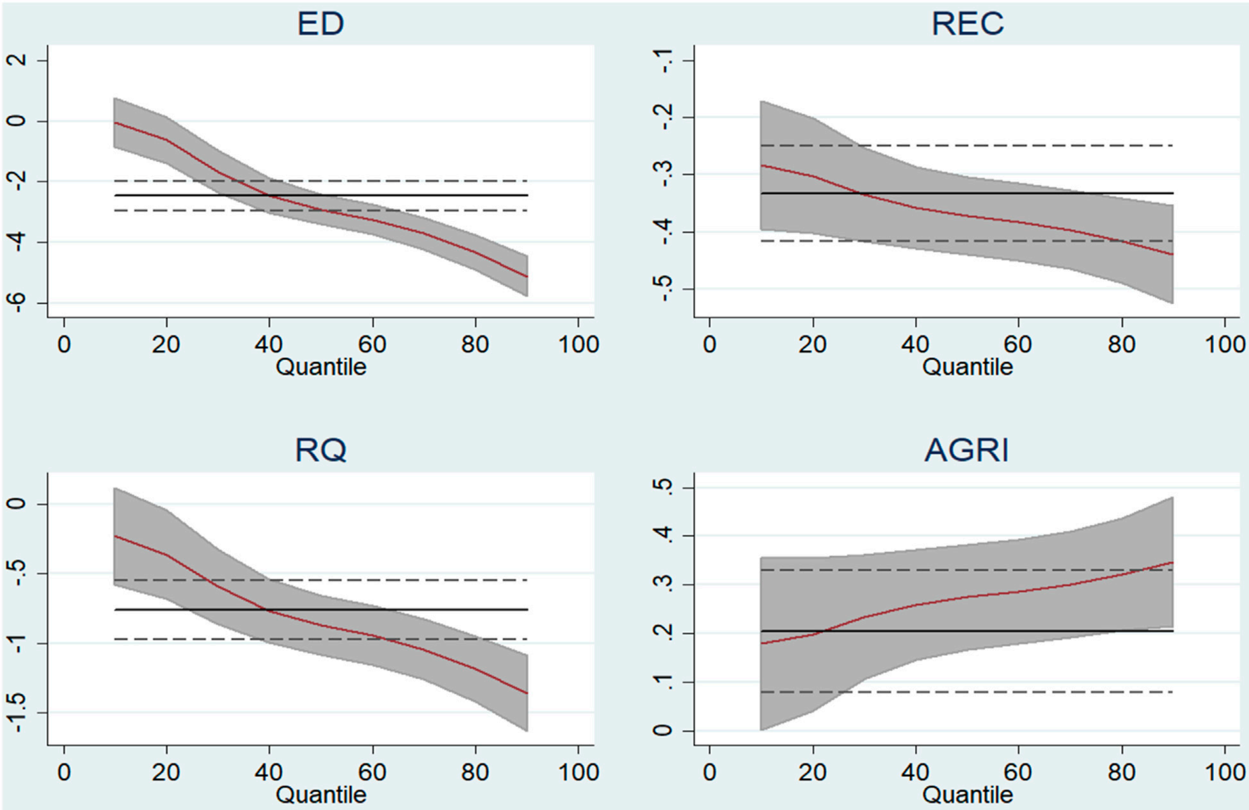

FIGURE 2 | Plotting parameters across quantiles in MMQR.

addition, **Table 6** elucidates that renewable energy has a negative and heterogeneous impact on GHG emissions across all quantiles in Asian economies. The larger coefficient value states that renewable energy refers to the process of reducing GHG emissions by protecting the environment (Fuinhas et al., 2017; Nathaniel and Iheonu, 2019). In the context of regulatory authority, the findings are consistent with the existing literature and present that regulatory authority is a solution to minimize GHG emissions. From the lower to upper quantiles, the coefficient value of regulatory authority, although insignificant in the 10^{th} quantile, has a negative and heterogeneous effect ranging from −0.23 to −1.36. Regulatory quality is a policy that seems to promote some social goods beyond the benefits of economic activities, such as environmental preservation (Adedoyin et al., 2020; Gungor et al., 2021). The dynamics of the parameter estimates across different quantiles are depicted in **Figure 2**. The estimated coefficients appear to follow distinct trajectories than their linear estimates (OLS type), suggesting that the coefficients respond differently across quantiles.

Figure 3 compares the estimated coefficients for all specifications used, including MMQR, FE, DOLS and FMOLS. The coefficient approach of MMQR is heterogeneous and provides a vibrant image in all quantiles, while the coefficients of DOLS, FMOLS, and FE are static. **Figure 2** represents that the coefficients of export diversification decrease from the lower to the upper quantiles, which indicates that more diverse export is favorable to the environment. Moreover, the coefficients of agricultural value-added are moving upward in the MMQR approach, representing that agriculture based on non-renewable sources in Asian countries is a poor motive for increasing the intensity of GHG emissions. There is an urgent need to promote advanced and eco-friendly procedures to escalate agricultural production while achieving the goal of a sustainable environment. In contrast, the coefficients of renewable energy and regulatory quality have effectively minimized the adverse effects of economic activities on society and the environment by providing reasonable solutions that help policymakers make decisions that can lead to environmentally friendly growth. Therefore, it is obvious that MMQR is an ideal and efficient technique when comparing all panel estimators to explain an inclusive demonstration of association among variables.

CONCLUSION

As a contribution to the environment-related literature, we explored the impact of export diversification, agricultural value-added, renewable energy, and regulatory quality on GHG emissions, taking Asia as a sample. To achieve the objectives of the study, we employ a novel technique, Method of Movements Quantile Regression (MMQR), recently proposed by Machado and Silva (2019). Clearly, MMQR is an ideal technique than the traditional panel quantile regression to explain an inclusive demonstration of association among variables at quantile distributions. This method is fierce against outliers and gives accurate estimates. Besides, we applied

FIGURE 3 | Comparison of panel estimations.

alternative methods such as FMOLS, DOLS and FE to get robust results.

The results of the study show that export diversification has a negative and significant impact on GHG emissions across all quantiles. On the one hand, higher export diversity tends to lead in a positive direction by conserving the environment. Agriculture, on the other hand, exerts a statistically significant and heterogeneous positive influence on the environment. The positive coefficients clarify that the interconnection of agriculture with GHG emissions is positive while moving from lower to upper quantiles. Renewable energy has a negative and heterogeneous impact on GHG emissions across all the quantiles. Therefore, renewable energy consumption has been vigorously contributing to diminishing the opposing effects on society and the environment through providing solutions to fulfil the purpose of sustainable development. In the context of regulatory authority, the findings present that regulatory quality is necessary to reduce GHG emissions.

Based on the findings of the study, policymakers in the Asian region should be encouraged to focus on export diversification, development of renewable energy sources and perceptions of regulatory quality policies to achieve the goals of green and clean energy production and a sustainable environment. Achieving these goals will be easier if a portion of the revenue generated from export diversification is spent on environmental purposes. Moreover, for a greener future for Asian countries, it is necessary to expand the use of renewable energy and adapt environmental technologies to the production process. Since overpopulation and the consumption of Asian countries are polluting the environment, these societies should be made more aware of the advantages of using and promoting renewable energies. Furthermore, better regulatory quality by Asian governments can contribute to environmental development by facilitating the use of renewable energy and diversification of exports. Therefore, policymakers in the Asian region should pursue environmental policies that simultaneously diversify exports, promote renewable energy, and increase regulatory quality. This work offers both professionals and academics further insight into future research that contextualizes export diversification and agriculture to examine additional movements in environmental quality around the world.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

MR: Writing Original Draft, Software, Formal analysis. ZF: Data Curation, Conceptualization, Writing Original Draft, Writing - Review & Editing, Resources. SS: Writing - Review & Editing, Investigation. AK: Writing - Original Draft, Investigation. UP: Writing Original Draft, Writing - Review & Editing, Resources.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

APPENDIX A: LIST OF SAMPLE ASIAN COUNTRIES

Sr.	Country	Sr.	Country
1	Armenia	17	Kyrgyzstan
2	Azerbaijan	18	Lebanon
3	Bangladesh	19	Malaysia
4	Cambodia	20	Mongolia
5	China	21	Nepal
6	Cyprus	22	Pakistan
7	Egypt	23	Philippines
8	Georgia	24	Russia
9	India	25	Saudi Arabia
10	Indonesia	26	Singapore
11	Iran	27	South Korea
12	Iraq	28	Sri Lanka
13	Israel	29	Thailand
14	Japan	30	Turkey
15	Jordan	31	UAE
16	Kazakhstan	32	Vietnam