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The nexus between political globalisation, higher education, health development and ecological innovation in China: evidence from a nonlinear approach

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ABSTRACT

The perspective of ecological innovation is widely studied around the globe because of its future demand in building a stable economy. Thus, the vital concept of the present study is to investigate the nexus between political globalisation and ecological innovation; while examining the impact of higher education (H.E.) and health development in China via the Quantile autoregressive distributed lagged (Q.A.R.D.L.) method. According to Cho et al. (2015), the Quantile Autoregressive lagged method is superior to the lasted estimation software because of its uniqueness of quantile base. However, through the analysis explanation of the ecological innovation concerning political globalisation, H.E. and health development are checked in long-run and short-run quantiles. The Q.A.R.D.L. technique investigations revealed that error correction parameters are negatively significant across all the quantiles. Hence this confirmed the presence of reversion to the long-standing association between ecological innovation and political globalisation, H.E. and health development. This implies that the affirmative impact of political globalisation (P.G.L.O.B.), H.E., H.D.L. and gross domestic product (G.D.P.) on ecological innovations emerges positive change in the environment of China. However, the Granger causality test describes the bi-directional relationship amongst the selected variables. Some potential implications for the China country are discussed in the last paragraphs of the study.

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1. Introduction

The revolutionary transformation in the world's milieu provides countless advantages in the social-economic progression of the nations, but still, the negative impact of this is undeniable, that industrialisation is responsible for environmental causalities such as ecological degradation. In this regard, scientists and environmentalists are engaged in moulding the societies into a green eco-environment through incredible

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inventions of ecological innovations (Baloch et al., 2021) firmly believe that supporting ecological innovations raises economic developments and decreases earthly depletions. Moreover, Zhang et al. (2020) established the insight over the concept of ecological innovations as green innovations; this ideology is supported by Bai et al. (2019). The main reason behind this was the procedures of developments are clean and eco-friendly. The production of the technologies and other mechanised systems brings efficiency and effectiveness to the traditional ways of production and nourishes the economic conditions. In the last three decades, wonders of green innovations in upgrading the pathetic conditions of the industries have been seen in industrialised countries (Wang & Yu, 2021). However, they worked on competent strategies, like economies integrating their internal and external operations to encourage the process of globalisation, as it is considered the most compatible econometric function to gain a sustainable and innovative environment (Novack-Gottshall et al., 2022). Similarly, a systematic approach to ecological innovation entices the emerging countries a lot, but not all nations are prosperous in carrying out the green innovation; for several reasons, one of the research-based causes is erroneous political globalisation (Destek, 2020).

While an association between political globalisation and ecological innovations grasp the attention of the scholars because, in this era of modernisation, it is impossible to mobilise solely and dependently; thus, establishing collaborative relationships around the globe is compulsory for the countries to achieve a competitive edge in the business market. In this regard, Sharif (2019) aligned the academic affiliation of political globalisation and ecological innovations that, more political engagement gathered more investments, enhanced trade liberalisation, increased technical expertise, skills nourishment, and mobility of goods and services, which generates economic and societal advantages to upgrade the financial stability. Similarly, economies that are politically integrated into business operations of the industries such as service, agriculture, and manufacturing, are uniquely adopting the green ways of conducting business (Sun et al., 2022). In other words, Coenen and Morgan (2020) stated that joined policies and reforms diminish the damaging consequences among the countries and create easiness in regulating the operations. Hence politicians play an eminent role in welcoming the ecological innovations in their nations. Undoubtedly, new and innovative globalisation procedures positively transform the economies (Gormus & Aydin, 2020) and mitigate the environmental pressure of non-organic energies because political globalisation destroys the barriers to acquiring higher education (H.E.) from different nations. Thus positive impact seems on the countries' economic growth if learning and knowledge transmit globally.

Typically, education not only modifies the academic background, income or status, but it collectively moulds the entire society to think and act intellectually to secure the world from a deficit eco-friendly nature. Biberhofer et al. (2019) demonstrated that the humiliation of a green environment through industrialisation negatively impacts the resourceful globe, the intensive need for H.E. is an essential factor to focus on. Indeed, if engineers and mechanics are educated about energy transition methods to construct eco-friendly things and omit less environmental pollution, the scale of revenues and gross domestic product (G.D.P.) increases abruptly (Peng et al.,

2020). According to Ouyang et al. (2020), researching and learning ecological innovations converts industrial production into green technical methods and improves efficiency and effectiveness in traditional operations. Even though surveys demonstrated that developed countries provide quality education to their employees through sponsorships, they mobilise globally to gain more ideas to invent ecological innovations (Shaturaev, 2021). However, the power of human intelligence is marvelous, but appropriate utilisation of this acumen in technical developments saves the entire population, earthly resources and overall environment from depreciating deliberately (Zahra, 2021). These green modifications in agriculture, industrial, and service sectors are the real examples of innovations; unfortunately, in the health development sector, there is vast room for innovative precedents as several benefits are incorporated if nations motivate their population to gain H.E. and implement the modern process of medication for the betterment of civilians.

However, to nourish the ecological innovations, experts can make the most from the health development factor; as stated by Iholkina and Iholkin (2019) innovation in the medical-related technical infrastructures in hospitals increases the ratio of life savings that ultimately enhances the healthy environment. Additionally, through the implementation of green, technically oriented machinery and systems, availability of the severe medical issues can easily be treated and cured, which provides incentives to the population to save their earnings from health expenditures (Comito & Pizzuti, 2022). Similarly, countries that are politically, socially and economically integrated invest funds to manufacture medical accessories that are eco-friendly in nature (Price & Nicholson, 2019) and normalise the usage of these green innovations in daily life. But still, these advanced tools and methods collapse when unskilled and untrained labour utilise them. Although, emerging economies like China face the revolting challenges in sustaining the efficiency and efficacy of health resource and service departments in hospitals that diminish the environmental stability (Zhou et al., 2020). However, continuous revolutions in ecological innovation in China emerged, but a neglected factor of health development became the reason for extreme environmental degradation.

Therefore, it's imperative to study the country of China to analyse the greenways and procedures of adapting the developmental health strategies and increase the ecological stability. According to the statistics, in 2020, China will cover almost 1.35 billion people who fall under the B.M.I. program policy and attain better quality and affordable health services. But still, the constant trend of increasing population in China increases the environmental dilapidation, which adversely affects the health environment of civilians; thus, focusing on green innovations in health development sectors becomes extremely important to get a green ecosystem. Even though the study's significant variable, i.e., H.E., requires severe concentration because this factor positively surges the economic strength (Kumari et al., 2019). In China, the maximum ratio of adults is reluctant to get a higher level of education. Although, statistic shows that the number of students enrolling in H.E. programs in 2020 will touch the 42millions, which is better than the previous years. To smooth down the operations of these variables, the administrative governance of China must participate actively to integrate, collaborate and mobilise the factor of political globalisation and increases

the number of ecological innovations. Based on these progressions, potential outcomes are expected in the depletion of environmental instability.

On that account, the present study selects China to examine the nexus between political globalisation and ecological innovation while analysing the role of H.E. and health development. However, these variables are not studied in the past in China. Thus, this study possesses distinctiveness amongst the previous publications. Secondly, the affiliation of health development with ecological innovation was ignored in the past due to severe environmental degradation. Hence motive of the current research is to highlight the benefits encounter in the health development sector if the essence of ecological innovations endures. The third novelty attached to the study is the technique used to demonstrate the data in recent years called the Quantile autoregressive distributed lagged (Q.A.R.D.L.) method. It is an authentic and accurate figure estimator and evaluator of short- and long-term results (Chien et al., 2022). The researchers used this method to upgrade the reliability of their explorations because the answers are in quantile form to provide the apparent crystal effects of dependent variables on independent variables. Ali et al. (2021) Stated that, through the Q.A.R.D.L. technique, estimations are accurate and helpful in establishing the new strategies and policies related to a discussed issue.

Furthermore, the study's organisation is categorised into five chapters; the first chapter elaborates on the background and understanding of the central theme and its variables. The second chapter represents the recent publications on related topics, and the third section explains the methodology adopted in the present study by the researchers. The fourth chapter elaborates on the data analysis part through the statistical estimation of the Q.A.R.D.L. method, finally, the five-part explains the conclusion and recommendations for the potential population.

2. Literature reviews

2.1. Ecological innovation and political globalisation

The numerous studies highlight political globalisation's engagements in upgrading the economies' environmental growth and show concern over the environmental degradation that occurs due to globalisation. Awosusi et al. (2022) suggest that excessive environmental issues profoundly influence and affect political modernisation conceptions. The term 'ecological modernisation' dates back to a debate in the Berlin municipal parliament on 22 January 1982, when an environmental representative from one of the opposition political parties proposed four ecological modernisations to the government: in industry, energy, mobility, and construction. Add-on organisations of state environmental protection policy make up the early phases of institutionalising environmental policy. Taking integrated, polluter-related policies focused on target groups is the next step in policymaking. In the second phase, it becomes evident that the traditional bureaucratic intervention mode cannot motivate polluters to change and trigger their innovative potential. Problem-specific, ad hoc constellations of involved players – with or without governmental intervention – frequently prove to be speedier and more efficient in this context (Jänicke & Jörgens, 2020).

However, according to the researchers Ovtchinnikov et al. (2020), economies that support more politicians, winning politicians, politicians on congressional committees with control over the industries, and politicians who join those committees all innovate more patents on average than stagnant economies, as stated in the study, although the difference is only significant for enterprises in non-connected industries. In addition, regardless of political activity status, firms in government-connected industries innovate less. In conclusion, this article provided unique evidence of a positive association between corporate political activism and innovation. It also found that strong political involvement has large positive intra-industry and local spillovers, resulting in increased aggregate industry and local innovation. The study by Kuo et al. (2019) stated that in the second decade of the twenty-first century, rapid technological proliferation and increased global competition had created a sense of urgency for governments of developed and developing nations alike to engage in major industrial revitalisation, leading to the worldwide emergence of something generically known as Industry 4.0, with a core of industrial transformation, renewal, and development. The global architecture in major industrial sectors is projected to be dramatically altered due to these critical government activities.

Furthermore, You et al. (2019) empirically tested the influence of environmental regulation on company eco-innovation and the moderating impacts of fiscal decentralisation and political competition using panel data from 1962 listed Chinese industrial businesses from 2004 to 2015. It is concluded that environmental legislation will likely boost enterprises' eco-innovation, eco-investment, and eco-planning innovation without China's fiscal and political promotion systems. Environmental regulation has had a major inhibitory impact on enterprises' eco-innovation, eco-investment, and eco-planning innovation under the influence of China's fiscal decentralisation system. Another evidence was extracted from the study of Zhang et al. (2019) when they conducted empirical research on the influence path of political ties on firm environmental performance using a sample of Chinese A-share listed enterprises. The findings revealed a substantial positive relationship between political connections and company environmental performance, with green technological innovation as a bridge between the two. Furthermore, public participation negatively impacts the relationship between political ties and firm environmental performance. The association between political connections and company environmental performance weakens as public participation increases, (Ahmad et al., 2021) showed acceptance of the above results estimations.

Moreover, Desheng et al. (2021) study examined the effect of political connections and the loss of political connections on enterprises' green technological developments. Using data from Chinese A-listed firms from 2012 to 2017, the authors designed a quasi-natural experiment to test the relationship between political connections and firm technology innovations in 2013, following an anti-corruption campaign event to improve corporate governance by limiting government officials' involvement in firms' top management. Results showed that political linkages impede enterprises' green technology developments and lower their environmental innovation output. It was also discovered that when a corporation lost its political links, the amount of green technology innovation increased dramatically. These previous explorations on political

globalisation and ecological innovations suggested that both variables are significantly interlinked with each other. Still, although the rules and regulations of the parliaments of the economies are different, some economies are making the most from upgrading their political engagements. Some economies are reluctant to integrate their market happenings.

2.2. Ecological innovation and higher education

To develop insight into ecological innovation and H.E., multiple kinds of research are previously published; likewise, the study of Wear (2020) claimed to be ontologically implicit in the tertiary or 'higher' educational triad of teaching, learning, and research. In practice, innovation is essential to a university's research function, and the same should be valid for guaranteeing continual, positive change in teaching and learning. Innovation does not undergo a 'semantic rehabilitation' until after a long period of industrialisation and rapid technological growth – a period that began in the late eighteenth century and continues to this day. Science contended with religion for precedence in the pursuit of knowledge and understanding, while economic theories simultaneously recreated production principles and models. Another declaration by Tseng et al. (2020) stated that Universities are a major source of knowledge creation; different industries are increasingly recognising the importance of scientific knowledge creation and seeking alliances with universities to increase their knowledge base and gain a competitive advantage. The Taiwanese government has established several policies and programs to improve universities' research innovation capacity and bridge the gap between academic research and industrial application. According to the data, U.I.C. funding is directly related to university technological innovation. In addition, mechanism incentives affect directly and moderately university researchers' involvement in and contribution to technology innovation.

Similarly, the fourth industrial revolution has highlighted various concerns in Korea, indicating the need for significant reforms in the industrial structure and H.E. institutions to prepare Korea for probable periods of technological unemployment, according to Jung (2020) report. They further stated that universities could contribute to know could production in two ways: by developing new information directly through academic research and by teaching a workforce. The study determined that the impact of a fourth industrial revolution will be immeasurable, although this will be heavily influenced by countries' economic, social, and cultural contexts. Jackson's (2019) article's expanded approach demonstrated how H.E. must participate more fully in learning cycles capable of absorbing and adapting to external market needs and information. It also revealed areas where industry and business leaders must urge more forcefully for educational transformation from various sources, not simply academic certification bodies. In collaboration with business leaders, H.E. must demonstrate where, how, and when H.E. programs should improve their piloting skills. In the face of technological upheaval, ambidexterity and absorptive aptitude can help keep H.E. relevant and current.

Conferring to the study by Slocum et al. (2019), the neoliberal impacts shift H.E.'s mission from education to training, reducing its ability to teach the critical thinking

skills required for future generations to achieve the Sustainable Development Goals. According to the research, consumer-centric policies and more business participation in curricula appear to be taking precedence over sustainability education. While private enterprises predominantly control tourism, it also relies on the public good that makes up the visitor experience. H.E. has faced many of the same challenges as other government services, including reduced funding and the influx of private and corporate universities providing new learning forms for working people. The goal of Anthony's (2020) study was to look into the current green practices used in Malaysian H.E. institutions to achieve sustainability by creating a multi-disciplinary comprehensive policy framework that would allow sustainability practitioners to collaborate more effectively in providing integrated data on green indicators linked to economic, social, and environmental dimensions of sustainability in H.E. institutions. As a result of the findings, a novel multi-disciplinary comprehensive policy framework based on identified Green indicators has been developed, which will provide information on how sustainability practitioners can implement green practices across universities.

In a nutshell, this past evidence directed the positive influence of H.E. on ecological innovations because, through knowledge, every department of the e-economy can nourish its operations through green technical innovation and mitigate environmental pollution and hazards (Song et al. 2020), although the present study investigates this in China's economy and provides more technical ways to convert their industrial processing into innovative green handling.

2.3. Ecological innovation and health development

The influential role of health development in sustaining ecological innovation grasps the attention of the environmentalist, who explains the relationship shared by these variables in this furious era of technical innovations. However, limited studies describe the importance of health development in the context of the green ecological invention; even though health is the pre-requisite for the regular operation of the human body and higher productivity (Zhang et al., 2022), the W.H.O. elaborated the definition of health development that progressive improvement in the health of the population reflected positive nourishment in the field of social and economic sectors. As per this definition, the significance of health development is seen clearly in developing the ideal green innovative market, related to this concern (Hou et al., 2022) researched ecological innovation production perspective while studying the variables of China's country, ecological environment and health development, here they analyse that from 2009 to 2016 China's economy successful adapted the ways of ecological innovations in health development sector which positively impacted the entire environment mainly east China, like innovative procedures through high mechanised machinery, provide advancement in the treatment of the diseases to secure the precious lives.

A similar outcome was presented in the study of Wang et al. (2019); this article analysed the influence of industrialisation and innovation on healthcare centres from the period (1990 to 2015) in China. The results indicate that a potential and effective

healthcare innovation ecosystem helps improve the patients' well-being because collaboration and adaption of newly invented models medicate health problems in a short time. However, Tehreem et al. (2020) reported the negative effect of industrialisation on the health development sector because extensive usage of harmful gases in production infected the healthy environment. Identical elaboration extracted by Saidi et al. (2021), when they did a case study in Norwegian on health care concerning the innovation, study targets to look at whether the innovative technology or devices are enabled in hospitals. Their findings revealed that technical infrastructures are less likely to use because of less knowledge to handle the innovative technological systems. Thus, the health department's possible results are not measurable when ecological innovation arises.

Additionally, scholars demonstrated that in the fourth industrial revolution, non-standard criteria of employment were carried out, which reduced the improvement in health and safety services. Also, trust in modern technologies usually causes the destruction of workers, such as mental health affected, ultimately unstable the ecosystem. Similarly, Schulman and Richman (2019) stated that high-tech innovation or transformed procedures in health care departments raised the expenditures of the health care centres when they investigated a compelling, innovative agenda. The statement signifies that highly innovative strategies in the health department increase the expenses of the treatments that directly depress the health of the citizens, especially in industrialised areas such as the U.S.A., China and Japan. Anyhow, positive incentives are maximum if the utilisation and governance of these ecological innovations in health sectors are appropriately regulated, even though green technological innovations significantly improve the healthy development of individuals who collectively nourish the entire environment (Zhou et al., 2021).

Previous assertions indicate that green growth in ecological innovation raises the developmental health sectors. On the other hand, industrialisation increases the market growth of the economies and adversely impacts the health of human beings (Garcia-Segura et al., 2020). Under such circumstances, this study targets to sustain the stability in China's ecology as this country is heading towards the highest edge of industrialisation. Hence it's compulsory to consider health development as a crucial factor for a sustainable environment.

Based on the aforementioned discussion from the literature regarding the selection of political globalisation, H.E., and health development, as the potential predictor for ecological innovation, the current study is an attempt to explore them within the context of China, which is a potential contribution to the literature and the practice because of the China potential and contribution to the global economy and trade.

3. Methodology

Factual studies elaborated that unit root tests encountered in time series analyses using macroeconomic variables. We considered the values of variables at the stationary level because it is assumed that the non-stationary values are erroneous. Although in the long term, the situation causes a loss of information. This problem led to the evolution of the cointegration test developed by Engle and Granger (1987); the series

consists of two stages; the process contains a unit root test at stationary values regressed at the first difference, which could prevent loss of information. The test validation is limited to one co-integrated vector. To overcome this limitation, Johansen (1988) has developed a multiple cointegration module based on the V.A.R. model that allows the user to determine if there's more than one cointegration among variables. According to a previous study, all macroeconomics variables that are modelled should not be stationary but should be fixed in their first difference, that is, I(1) in Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (2009) cointegration tests.

An exemption exists in the boundary test technique of Pesaran et al. (2001) that variables can be a mixture of I(0) and I(1), excluding only I(1) of all series, but none of them must have a degree of integration of I(2). The co-integration approach was prolonged to quantile regression by Xiao (2009). Endogeneity is measured by taking into account the integrated regressors' leads and lags. Additionally, the cointegration test is validated for conditional heteroscedasticity and permits additional volatility of dependent variables such as ecological innovation. In a nutshell, before Cho et al. (2015) presented the Q.A.R.D.L. method, the quantile cointegration technique assessed both regression techniques and provided robust model expansion options for economic panel data series.

3.1. Q.A.R.D.L. method

This study used the Q.A.R.D.L. method to detect the nonlinear relation between ecological innovation, political globalisation, H.E. and health development. Cho et al. (2015) suggested that the quantile autoregressive distributive lagged method determined the effect of ecological innovation on its determinants in the long run. The study was done in China. Further, the Wald test was used to check the dependability of parameters in short and long-term quantile equilibrium.

Firstly, the A.R.D.L. method was inscribed:

$$\begin{aligned} ENIV_t = \alpha + \sum_i^p \beta_1 ENIV_{t-i} + \sum_i^q \beta_2 PGLOB_{t-i} \\ + \sum_i^m \beta_3 HE_{t-i} + \sum_i^n \beta_4 HDL_{t-i} + \sum_i^r \beta_5 GDP_{t-i} + \varepsilon_t \end{aligned} \quad (1)$$

In this equation, ε_t denotes error due to white noise. ε_t is created by a natural log series of ecological innovation {*ENIV*t), political globalisation (P.G.L.O.B.), higher education (*HE*t), health development (*HDLt*), $ENIV_{t-1}$, Y_{t-1}), Where, lag orders are p, q, m, n and r, according to Schwarz Info Criterion (S.I.C.).

Further quantile suggested another framework of Q.A.R.D.L. method as follows:

$$\begin{aligned} Q_{ENIVt} = \alpha(\tau) + \sum_i^p \beta_1(\tau) ENIV_{t-i} + \sum_i^q \beta_2(\tau) PGLOB_{t-i} + \sum_i^m \beta_3(\tau) HE_{t-i} \\ + \sum_i^n \beta_4(\tau) HDL_{t-i_{t-i}} + \sum_i^r \beta_5(\tau) GDP_{t-i} + \varepsilon_t(\tau) \end{aligned} \quad (2)$$

In the given equation, quantiles are $0 < \tau < 1$ and $\in t\ (\tau) = \mathrm{EI}t - QEIt\ (\tau/\in t-1)$. Data analysis was done by using the pair of quantiles. Where τ is {0.05, 0.10, 0.90

and 0.95}. Equation 2 was comprehensive due to the probability of correlation in white noise error.

Next, Equation 3 was revised to give the error correlation model of Q.A.R.D.L.;

$$\begin{aligned} Q_{\Delta EINV_t} = {} & \alpha(\tau) + \rho ENIV_{2t-i} + \varphi_1 PGLOB_{t-i} + \varphi_2 HE_{t-i} + \varphi_3 HDL_{t-i} + \varphi_4 GDP_{t-i} \\ & + \sum_i^p \beta_1(\tau) ENIV_{t-i} + \sum_i^q \beta_2(\tau) PGLOB_{t-i} + \sum_i^m \beta_3(\tau) HE_{t-i} \\ & + \sum_i^n \beta_4(\tau) HDL_{t-i_{t-i}} + \sum_i^r \beta_5(\tau) GDP_{t-i} + \varepsilon_t(\tau) \end{aligned} \tag{3}$$

Cho et al. (2015) reviewed equation three to use it to determine the error correction model dimension.

$$\begin{aligned} Q_{\Delta CO_{2t}} = {} & \alpha(\tau) + \rho(\tau)(CO_{2t-i} + \omega_{1(\tau)} GTI_{t-i} - \omega_2(\tau) NRR_{t-i} - \omega_3(\tau) EIN_{t-i} \\ & + \omega_4(\tau)\,\mathrm{SIN}_{t-i}) + \sum_{i=1}^{p-1} \beta_1(\tau) \Delta CO_{2t-i} + \sum_{i=0}^{q-1} \beta_2(\tau) \Delta GTI_{t-i} \\ & + \sum_{i=0}^{m-1} \beta_3(\tau) \Delta NRR_{t-i} + \sum_{i=0}^{n-1} \beta_4(\tau) \Delta EIN_{t-i} \\ & + \sum_{i=0}^{r-1} \beta_5(\tau) \Delta\,\mathrm{SIN}_{t-i} + \varepsilon_t(\tau) \end{aligned} \tag{4}$$

where y $\beta^* = \sum \beta 1\ \rho - 1\ i{=}1$ was used to calculate the short-term effect on previous and current ecological innovations. Where $\beta^* = \sum \beta 2\ q - 1$, the $i{=}1$ captures the Y in the present stage. The same method was used to find the cumulative effect of political globalisation, H.E. and health development, where the coefficient of the speed of adjustment p is significant and negative.

Wald test was used to regulate the asymmetric effects of ecological innovation, political globalisation, H.E. and health development. Both in the long and short term. Furthermore, this test was also used to evaluate the specific null and alternative hypotheses. Conferring to Cho et al. (2015), the long and short-term factors may be quantile-based, suggesting that Q.A.R.D.L. method coefficients might be dissimilar on each quantile, implying that these coefficients could be influenced at any time. The Wald test influence also be used to verify the limits of the long and short-term coefficients with and amongst quantiles (Cho et al., 2015).

3.2. Granger causality in quantiles test

Granger presents a causality analysis framework to determine whether or not a variable is a precursor to one another. Mainly the Granger causality test presumes that the current value of the dependent variable is directed by itself and determines the lagged value of an independent variable. After Granger's Method, many new ideas and techniques were developed, but in the current study (we) applied Granger Method lately introduced (Troster, 2018) to examine the quantile causal of ecological innovation with political globalisation and H.E. and health development. As per the estimations of Granger, if preceding X_i does no approximation Y_i by giving Y_i (previous), then it means X_i does not granger cause Y_i (Granger, 1969).

Table 1. Results of descriptive statistics.

Variables	Mean	Min.	Max.	Std. Dev.	J-B Stats
EINV	1.074	0.150	1.100	0.161	16.139***
PGLO	0.136	0.084	0.199	1.028	20.081***
HE	1.052	0.126	1.082	0.147	17.155***
HLD	0.180	0.091	1.005	1.059	22.023***
GDP	1.065	0.135	1.111	0.172	19.127***

Note: The asterisk ***, ** and * represent level of significance at 1%, 5% and 10%, respectively.
Source: Author Estimation.

In this article, it is hypothetical that $\left(N_i = N_i^y,\ N_i^X\ \right)' \epsilon\ R^e$ is a described vector, $s = o + q$ and N_i^X are measured to be an earlier directed group of $X_i N_i^x := (X_{i-1},\ \ldots,\ X_{i-q}\ )' \in$. From X_i to Y_i, the succeeding equation signifies the null of Granger non-causality.

$$H_o^{X \nmapsto Y}:\ F_Y\left(yN_i^Y, N_i^x\right) = F_Y\left(yN_i^Y\right),\ for\ all\ y \in R \tag{5}$$

In this equation, the distribution of Y_i conditionally is signified by $F_Y\left(.|N_i^y, N_i^x\right)$ by giving(N_i^y, N_i^x).

By organising the Q.A.R. technique m(.), the Subsequent equation is used for the finding of DT check based on null of the Granger causal relationship.

$$QAR(1): m^1\left(N_i^Y,\ \partial(\pi)\right) = \lambda_1(\pi) + \lambda_2(\pi)X_{i-1} + \mu_t \Omega_Y^{-1}(\pi) \tag{6}$$

In the above equation, $\partial(\pi)$ is assessed to be in the highest possibility of equal points in quantiles and is equal to $\lambda_1(\pi)$, $\lambda_2(\pi)$ and μ_t.

Moreover, in Equation 6, $\Omega_Y^{-1}(.)$ = opposite for essential distribution function predictably. The present study investigates the lags factor by illustrating the approach of Q.A.R. in Equation 6 to confirm the causality between the determinants.

4. Data analysis and interpretation

Table 1 reports the estimation of descriptive analysis and Jarque-Bera (J.B.) test on the selected variables such as ecological innovation, political globalisation, H.E., health development and G.D.P. (economic growth as the controlling variable). The E.I.N.V. has the highest variability of (1.074) among the other variables like P.G.L.O.B., H.E. and H.L.D. and the second-highest average figure found in the component of GDP (1.065). Whereas the goodness of fit test, i.e., the J.B. test, should meet the criteria of positive values at a significance of 1% to reject the null hypothesis, here in the study, all the selected variables are positive and meet the consideration of 1% significance level thus the rejection of null hypothesis is confirmed. Hence, the need for the Q.A.R.D.L. method is essential and credible for further explorations.

Before quantile technique, testing of correlation test is compulsory to validate the vice versa relationship. The correlation results are presented in Table 2; here, the diagonal shape of '1' indicates that the impact exerted on one variable is the same amount of effects faced by another variable. All the positive and significant values in the table illustrate the direct relationship between E.I.N.V. and other determinants.

Table 2. Correlation test results.

Variables	EINV	PGLO	HE	HLD	GDP
EINV	1				
PGLO	0.752***	1			
HE	0.676***	0.135	1		
HLD	0.881***	0.074	0.056	1	
GDP	0.909***	0.250*	0.529**	0.400**	1

Source: Author estimation.

Table 3. Results of Q.A.R.D.L.

Quantiles (τ)	$\alpha_*(\tau)$	$\rho_*(\tau)$	$\beta_{PGLO}(\tau)$	$\beta_{HE}(\tau)$	$\beta_{HLD}(\tau)$	$\beta_{GDP}(\tau)$	$\varphi_1(\tau)$	$\omega_0(\tau)$	$\lambda_0(\tau)$	$\theta_0(\tau)$	$\acute{\varepsilon}_0(\tau)$
0.05	0.059	−0.426**	0.268***	0.128	0.304***	0.337*	0.511***	0.082	0.067	0.100***	0.095***
	(0.990)	(-2.051)	(3.352)	(1.046)	(3.157)	(1.659)	(3.162)	(1.218)	(1.048)	(2.900)	(3.138)
0.10	0.073	−0. 403***	0.237***	0.174	0.352*	0.316**	0.347***	0.056	0.095	0.061***	0.057***
	(1.055)	(-3.174)	(3.180)	(0.182)	(1.823)	(2.041)	(3.274)	(1.149)	(0.180)	(3.135)	(3.157)
0.20	0.068	−0.374*	0.252***	0.154	0.331**	0.329***	0.423***	0.077	0.058	0.094**	0.084***
	(1.182)	(-1.825)	(3.369)	(1.057)	(2.052)	(3.183)	(3.183)	(1.052)	(1.076)	(2.046)	(3.162)
0.30	0.084	−0.310***	0.231***	0.209	0.242*	0.348*	0.361***	0.063	0.084	0.055*	0.069***
	(1.361)	(-3.162)	(3.047)	(0.196)	(1.900)	(1.732)	(3.659)	(1.168)	(0.162)	(1.828)	(3.181)
0.40	0.052	−0.362***	0.300**	0.138	0.260***	0.400**	0.455***	0.090	0.076	0.082***	0.085***
	(0.976)	(-3.700)	(2.636)	(1.050)	(3.168)	(2.067)	(3.190)	(1.493)	(1.053)	(3.155)	(3.149)
0.50	0.090	−0.339***	0.311**	0.201**	0.245**	0.362*	0.372**	0.055	0.091***	0.077	0.074***
	(1.290)	(-3.168)	(2.172)	(2.043)	(2.031)	(1.820)	(2.800)	(1.141)	(3.192)	(1.124)	(3.190)
0.60	0.066	−0.350**	0.255**	0.274***	0.173	0.339***	0.514***	0.086	0.065*	0.059	0.056***
	(0.751)	(-2.491)	(2.281)	(3.165)	(0.685)	(3.134)	(3.370)	(1.371)	(1.700)	(1.471)	(3.155)
0.70	0.075*	−0.400**	0.279	0.168*	0.122	0.383***	0.362***	0.063	0.086**	0.090	0.098***
	(1.784)	(-2.147)	(1.665)	(1.752)	(1.060)	(2.981)	(3.151)	(1.158)	(2.069)	(1.153)	(3.186)
0.80	0.058*	−0.364**	0.121	0.200***	0.060	0.530**	0.449***	0.075	0.069***	0.065	0.067***
	(1.863)	(-2.382)	(1.390)	(3.164)	(1.391)	(2.050)	(3.646)	(1.249)	(3.173)	(1.080)	(3.137)
0.90	0.094**	−0.349*	0.168	0.211**	0.056	0.362***	0.350***	0.054	0.075**	0.083	0.084***
	(2.072)	(-1.867)	(1.157)	(2.043)	(1.272)	(3.178)	(3.638)	(1.135)	(2.048)	(0.847)	(3.166)
0.95	0.067**	−0.410*	0.299	0.279*	0.029	0.344***	0.521***	0.080	0.049***	0.054	0.059***
	(2.160)	(-1.900)	(1.273)	(1.800)	(0.895)	(3.689)	(3.384)	(1.171)	(3.656)	(1.390)	(3.200)

Note: The table reports the quantile estimation results. The t-statistics are between brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: Author estimations.

This states that an increase or decrease in one variable influences the other variable; thus, contribution toward ecological innovation automatically surges economic growth in China.

In Table 3, the results of the Autoregressive Distributed lag (Q.A.R.D.L.) test are presented, which shows negatively significant *p*-values in (0.05 till 0.95) quantiles, i.e., estimated speed of adjustment. Hence, reversion to the long-run equilibrium in China is confirmed between ecological innovation, political globalisation, H.E., health development and G.D.P. Even though the highest P-value is found at the upper quartile of (0.05), which is (−0.426). However, in the long-run, P.G.L.O.B. is positively significant with ecological innovation in the upper quartile of (0.05–0.60) while the lower quartile of (0.70–0.95) is non-significant. This indicates that in China, political globalisation encourages ecological innovation but later, the level of significance decreases; past exploration by Schulz and Feist (2021) also supports the engagement programs of political governance because through mobilisation, the newly green ways emerge in the economy. Another study by Bulkeley (2021) stated that economic collaborations between the countries increase good terms in trading especially; this

develops the potentiality to stabilise their motherland and provide incentives to other countries. Whereas H.E. shows a non-significant effect on ecological innovation in upper quartiles such as (0.05–0.40) but gradually from (0.50) the significance level increases and becomes high at (0.60 or 0.80), this declaration states that in China the outcome through H.E. is relatively low at the start but after sometime education plays a vital role to innovate green ecosystem. Zafar et al. (2021) conducted a study on the role of education and technology in Asia Pacific countries and got the same results, this study also signifies that through, education overall society change is observed in the long-run equilibrium, which sustains the eco-friendly environmental conditions.

Moreover, the health development elaborates the positive and significant relationship with ecological innovation in the upper quartile and highest at 0.40, but after the middle quartile, a non-significant impact has been observed in China. Such exploration signifies that socio-economic, procedures, i.e., green innovation of health development increase human well-being, Martela and Sheldon (2019) emphasise that the mental and physical health of humans are essential to gain prosperity in the businesses as well. Qi et al. (2020) describe the environmental and economic benefits of implementing the ecological innovative strategies in every sector such as hospitals, the food industry, and business entities to secure human well-being. Thus, China must ensure progressive increment in green technical innovation in regard to the healthy development of their civilians. Similarly, another factor of G.D.P. is positively significant with ecological innovation because green technology or strategies are organic in nature and must abate ecological degradation in China. Although the growing industrialisation haunts China's green economy of China still gradual developments of ecological innovations are high at (0.60 to 0.95). Numerous studies support the positive relationship between economic growth and ecological innovations. Likewise, Baloch et al. (2021) explored the vast difference after adopting the green tactics in their service and industrial sectors; the range of financial revenues increased outstandingly, and economic growth flourished.

Furthermore, the short-run analysis shows that previous values of ecological innovation have significant and positive affiliation with the p-values of present ecological innovations; a similar situation is observed with the factor of G.D.P. in the short-run with the current E.I.N.V. These circumstances boost the potential of China to develop innovative inventions that are more organically healthy. Although P.G.L.O.B. indicates no relationship in short-run analysis with ecological innovation, H.E. has a positive and significant connection in lower quartiles. Still, H.D.L. also has a significant relationship in the upper quartiles of the short-run. However, the indices of China suggested incorporating these future-oriented economic factors presented in the present study to raise environmental stability.

In Table 4, the results of the Wald test were reported, which identified the statistic of linearity in the context of parameter consistency. All the values represented the rejection of the null hypothesis because the P-values are significant at (0.00***). Furthermore, the statistic of long-run analysis infers that each quantile supports the null of linearity and rejects the speed of adjustment parameter. Hence, this signifies the dynamic results between E.I.N.V. and political globalisation, H.E., health

Table 4. Results of the Wald Test for the constancy of parameters.

Variables	Wald-statistics
ρ	6.947***
	(0.000)
$\beta_{PGLO}(\tau)$	12.823***
	(0.000)
$\beta_{HE}(\tau)$	3.181***
	(0.000)
$\beta_{HLD}(\tau)$	5.054***
	(0.000)
$\beta_{GDP}(\tau)$	4.999***
	(0.000)
φ_1	2.775**
	(0.034)
ω_0	3.149***
	(0.000)
λ_0	6.689***
	(0.000)
θ_0	3.171***
	(0.000)
$\acute{\varepsilon}_0$	5.408***
	(0.000)

Source: Author estimations.

development and G.D.P. For instance, China is involved in enormous trading activities with other countries that directly surge the political gatherings and increase globalisation. Thus, the impact of these engagements results in the emergence of green technologies, which nourish the areas of H.E. and the health development sector. Lou et al. (2021) also describe the positively significant affiliation in the long-run and short-run among the variables of green innovation and economic growth, whereas (Chien et al., 2021) stated the negative association of globalisation in the eco-friendly environment of the economy. Although, the results of China genre support the positive role of these variables in the environmental stability.

After the Wald test, the results of the Granger-causality test are illustrated in Table 5; here, all the p-values in every column of each quantile (0.50–0.95) are significant and reject the null hypothesis. Additionally, the bi-directional causal relationship observed between variables, for example, increased green innovations in China for the betterment of the ecology increases the G.D.P. per capita (Wang et al., 2020) stated that O.C.E.D. countries designed green technical procedures in every department to lessen the environmental degradation and increases their market growth. However, in the results, ecological innovation and political globalisation are positively significant to each other. In the past, the evidence of the positive relationship between P.G.L.O.B. and environmental innovation showed by Iqbal et al. (2021) when an investigation was done on political activities and their influence on the economy in … country. Same as E.I.N.V. and H.E. affiliates directly, if a greater ratio of the population is definitely highly educated, new ideas and perceptions emerge to cultivate more eco-friendly machinery and equipment which bring stability to the environment (Sharif, 2019) showed their agreement on these explorations. Similarly, Health development and ecological innovation have a significant causal relationship. In the study by Yan (2019); it is demonstrated that advanced and green infrastructure

Table 5. Results of Granger causality in quantiles (Troster, 2018).

Quantiles	$\Delta EINV_t \downarrow \Delta PGLO_t$	$\Delta PGLO_t \downarrow \Delta EINV_t$	$\Delta HE_t \downarrow \Delta PGLO_t$	$\Delta HE_t \downarrow \Delta EINV_t$	$\Delta HLD_t \downarrow \Delta PGLO_t$	$\Delta HLD_t \downarrow \Delta EINV_t$	$\Delta GDP_t \downarrow \Delta PGLO_t$	$\Delta GDP_t \downarrow \Delta EINV_t$
[0.05–0.95]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.05	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.40	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.80	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.95	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: This table reports the *p*-value for the Granger causality in Quantiles results.
Source: Authors estimation.

of medical instruments helps decrease the mortality rate because of their timely effectiveness.

5. Conclusion and policy implications

The ultimate concept of the present study is to investigate the nexus between political globalisation and ecological innovation; while examining the impact of H.E. and health development in China via the Q.A.R.D.L. technique. According to Cho et al. (2015), Quantile Autoregressive lagged method is superior among the latest estimation software because of its quantile base uniqueness of the ecological innovation concerning globalisation, H.E. and health development are checked in long-run and short-run quantiles, whereas G.D.P. act as the controlling variable. After this, the Wald test statistics are run on the data to identify the causal relationship among E.N.I.V., P.G.L.O.B., H.E., H.D.L. and H.D.L and vice versa.

The Q.A.R.D.L. technique investigations revealed that error correction parameters are negatively significant across all the quantiles. Hence this confirmed the presence of reversion to the long-standing association between ecological innovation and political globalisation, H.E. and health development. This implies that the affirmative impact of P.G.L.O.B., H.E., H.D.L. and G.D.P. on ecological innovations emerges positive change in the environment of the China. However, the Granger causality test describes the bi-directional relationship amongst the selected variables. Therefore innovative treaties among the countries enhance the political emergence that ultimately nourishes China's economic growth. Additional contributions are employed by H.E. and health development in ecological innovation to stabilise the economic downfall in terms of environmental degradation.

5.1. Implications from the study

According to the above identifications, the empirical implications must be potential and rational to implement in the surroundings of China. For example, China is one of the giant exporters; thus to make the most from this, China government should

integrate green mega-projects into their own country and spread eco-friendly procedures in industrial sectors mainly. By doing this, deterioration and deficit ratio of ecological footprint minimise. Another implication is that political leaders of China resolve their conflicts with the other developed countries and mobilise their population to gain H.E. and learning of the green technical innovations that mitigate environmental pollution. This is how political globalisation enhances and becomes productive in the escalation of overall China's economy.

Therefore, it is more effective to provide the policy implications based on the significance level of the quantiles. Such as H.E. in lower quartiles is more significant. Thus, institutional organisations increase the sponsorship program budgets, in the long run, to attract more students toward H.E., in this way more intellectual innovations are expected in the future. Same techniques applied by the government in establishing the strategies for health development like, in upper quartiles, the significance level are high so more health-related green technologies launched at that particular time and also mental health incentive programs must be generated by the organisation and business entities of China to gain the employee trust and increase their efficiency and effectiveness. In this way, China will progress economically through ecological innovation, where they are falling behind.

5.2. Limitations and future directions

Similar to any other study, the current study also possesses various limitations. For instance, the current study is focused on China's context, and hence the exploration of other economies would be an additional contribution to the literature. In addition to this, the current study follows the Quantile-based regression, whereas exploration of the aforementioned relationships through N.A.R.D.L. and B.A.R.D.L. could also lead to insightful findings. Lastly, ecological innovation is a need of the current era because of reducing the adverse effects on the environment through maximum consumption of the resources in an environment-friendly manner; hence more predictors need to be studied which can explain this phenomenon in further detail.

Disclosure statement

No potential conflict of interest was reported by the authors.

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