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Nexus Between Foreign Direct Investment Inflow, Renewable Energy Consumption, Ambient Air Pollution, and Human Mortality: A Public Health Perspective From Non-linear ARDL Approach

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A huge foreign direct investment (FDI) inflow has been witnessed in China, though on the one hand, it brings a significant contribution to economic growth. On the other hand, it adversely affects the ambient air pollution that may affect human mortality in the country. Renewable energy (RE) usage meets the country's energy needs with no adverse effect on the environment. Therefore, this study is trying to empirically analyze the effect of FDI inflow on human morality and RE consumption in China. We used time-series data for 1998–2020 and applied a non-linear ARDL approach for the estimations. The empirical outcomes suggest that FDI inflow positively affects mortality and RE. There is also unidirectional causality running from RE and pollution to mortality. In addition, the relationship among the variable verifies the existence of a non-linear relationship. The government needs policy guidelines to further boost FDI inflow due to its positive aspects. However, to reduce the negative effect on the environment and human morality, the extensive usage of RE should be adopted. Indeed, proper legislation for foreign firms might be a good step toward quality environmental and longevity of human health in society.

Keywords: FDI inflow, human mortality, renewable energy, NARDL, China

INTRODUCTION

China remained a top priority for foreign investors due to low-cost labor, high-tech industrial structure and good law and order. Since China opened up trade in 2002 by entering WTO, various foreign investment reforms resulted in a massive inflow of foreign direct investment (FDI). The FDI inflow significantly contributes to economic well-being, but it may have adverse consequences on environmental pollution and mortality (1, 2). Although less attention is given to this aspect, this study empirically investigates the relationship between FDI inflow, ambient air pollution (AAP), mortality, and renewable energy (RE) in China. In recent years, FDI inflow has been increased in many countries of the world (3). There are many benefits associated with FDI inflow for the host country regarding skills transfer, capital, technology transfer, export promotion, and market access. The economic theory concludes that FDI enhances various performance indicators of the host country. FDI may enhance growth, encourage the adoption of new technologies, and stimulate knowledge transfer in terms of skills acquisition and labor training (4). The FDI inflows are vital for boosting domestic investment and can turn the economy's growth on the right trajectory by increasing production, export, and employment opportunities.

Furthermore, the FDI inflows can increase the host country's export capacity, causing the developing country to increase its foreign exchange earnings. In addition, FDI may provide a positive effect on human health by increasing the income and higher health spending; however, apart from the positive aspect of FDI, there are some negative effects associated with FDI inflow; like the abundance of FDI inflow can make the host country polluted, which will have adverse consequences on the human health of the host country's residents in terms of death rate, infant mortality, and other serious types of mortalities (5). The drawback of FDI inflow is the degradation of the air quality caused by a high level of air pollution. The declination of air quality leads to lung cancer, heart disease, risk of stroke chronic, and acute respiratory diseases, such as asthma (6). Globally, the emission of dangerous gases like CO_2 and NO_2 has serious implications for the world's global environment and human health. However, the FDI inflow with a special focus on RE helps to reduce pollution and ensure the production process with no or fewer adverse effects on the environment, which ultimately leads to a positive effect on human health and mortality (7).

It has been evident that FDI inflow causes both scale and composition effects. The scale effect concerns the pollution emission due to enlarging the production and composition effect that arises due to the change in the production pattern of the country toward efficiently produced goods. Dean (8) argues that FDI may positively affect the environment in the long run due to the demand for cleaner goods. Environmental pollution has significant consequences for both human beings and the economy. This will increase health expenditures and social costs (9). Therefore, pollution may directly decrease output by decreasing productivity labor. It is also a serious concern that may impose many health problems, i.e., life expectancy decreases and mortality and death rates increase. Overall, the degradation of environmental quality leads to adverse implications on mortality.

Similarly, Lofdahl and Gasser (10) argue that more aggressive activities of MNC's have increased the scale of international trade and production, thereby putting pressure on the environment in terms of dangerous gases, which badly affect human health by reducing the life expectancy and increasing the human mortalities. Kunce et al. (11) state that oil and gas firms make a trade-off in the intensity of production and environment. Belloumi (4) confirms the effect of FDI inflow on the environmental quality and states that more economic growth can negatively affect the quality of the environment of a country. Environmental pollution has adverse implications for both human well-being and the economy, and it imposes a serious cost for an increase in health and social costs (12). The various determinants of environment, i.e., physical and social environments and lifestyle, are important exogenous determinants that can affect human life (13). The physical environment comprises factors, i.e., noise and heat, radiations, hazardous substances, chemicals, bacteria, and viruses, which may positively or negatively affect human health and mortality (14).

Similarly, building density, accessibility of public transport, and the next-door availability of green and open spaces for recreation are considered in the paradigm of the physical environment. These also affect mortality and health status (15). Human morality and air pollution have negative associations; in history, the disaster in the Meuse valley in 1930 and in London in 1952 are a few examples of environmental pollution affecting mortality (16).

Most research studies, focusing on foreign direct investment and health conditions, pointed out that highly penetrated industries with FDI have higher economic insecurity and lead to bad health conditions of the workers (17). Herzer and Nunnenkamp (18) explored 14 countries for the relationship between FDI and health conditions and suggests that FDI is linked with a lower life expectancy rate in host countries and an increasing mortality trend. These factors negatively affect human health. Jorgenson (19) concludes that FDI is associated with elevated water pollution, affecting kids and infant mortality. At the same time, the study of Herzer and Nunnenkamp (18) concluded a negative relationship between health conditions and FDI in developed countries. However, in contrast, a positive effect of FDI for the host country has been evidenced by various studies between FDI and health conditions in different countries. Alsan et al. (20, 21); and Siddique et al. (22) predict a positive relationship between health conditions and FDI. They argued that FDI might positively affect human health if the investment is more driven toward clean technologies in production. Nagel et al. (23) also justify the positive nexus between FDI and health condition, investing in the case of 179 countries with low income and a negative relationship for the countries in the higher-income slab. Extending the same behavior of the relationship, Alam et al. (24) report the significant impact of FDI on health spending, illiteracy, life expectancy, and food supply in Pakistan using the Granger causality test. The results of the study confirmed that spending on health improved life expectancy. In the long run, FDI helps to reduce infant mortality (25, 26). They also examine the relationship between FDI, infant mortality, household consumption, and life expectancy in Tanzania using ARDL.

A positive short-run impact was predicted between FDI and infant mortality. Over the last few years, the nexus between FDI inflows and air pollution with economic growth has been intensively and empirically analyzed. Most of the studies in this regard document that a higher level of FDI inflow positively affects economic growth but at the same time causes more

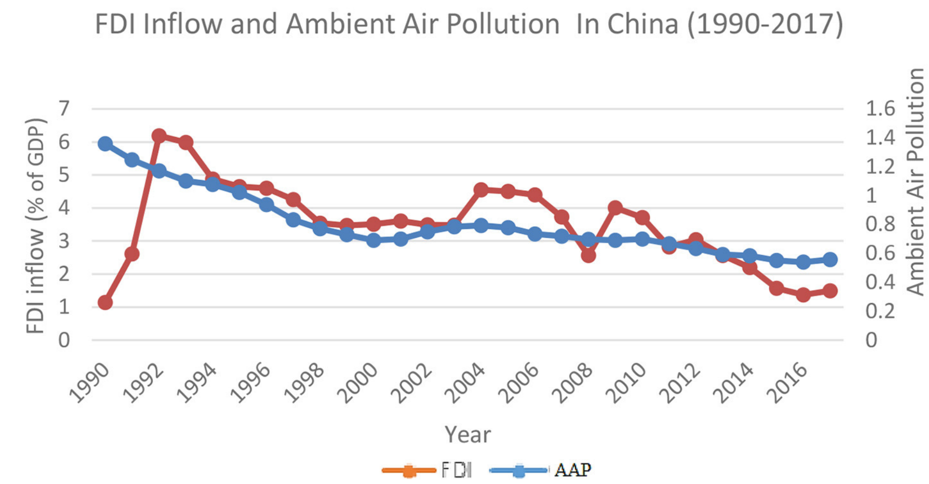

FIGURE 1 | Foreign direct investment (FDI) inflow and ambient air pollution.

emission of CO_2 and makes the environment hazardous (27); while some other studies, also predict the significant relationship between FDI inflow, economic growth, and CO_2. These studies evidenced the long-run causal relationship between FDI and CO_2 (28–30). Many studies in the same portfolio, also confirm the causal relationship between FDI and the CO_2 emissions (31–33). But some of the studies confirm that FDI characterized by cleaner energy would have a positive impact on economic growth. However, others concluded negative impacts (34, 35).

Renewable energy with pollution and mortality is well explored in literature. Numerous studies suggested that RE consumptions provide a clean environment with fewer emissions of dangerous gases, i.e., CO_2, SO_2, and NO_2 (36–47). Indeed, fossil fuels are the key source of greenhouse emissions and other air pollutants having a negative connection with human health, and these lead to respiratory and cardiovascular diseases. The contribution of renewables is to decrease fossil fuels and allied air pollutant emissions and positively influence human health (48). The study of Apergis et al. (49) confirmed a unidirectional causality that runs from RE consumption to health expenditures in the long run, while bidirectional causality between health expenditures and CO_2 emissions. Jebli (50) explored a bi-directional long-run causality running from health to renewables waste consumption for Tunisia. An empirical study by Newhouse (51) confirmed that green technology and RE reduce the health expenditure of the USA. RE use and green practices implementation in business and logistical operations improve environmental sustainability and decrease health expenditure (52). The low pollution level could reduce human normality and improve life expectancy and quality of life (53, 54).

This study tries to empirically investigate the relationship between FDI inflow, RE consumption, and mortality, taking the case of China. This study contributes to the existing literature from the following aspects; firstly, FDI and mortality have not been studied for China since large FDI inflow has been observed in China; therefore, this study uses the case of China to understand the implication of FDI on mortality in China. Secondly, most previous research used linear methodologies to analyze the FDI and mortality, CO_2 emissions. The AAP and RE trend in China shows a dynamic trend that provides a bias to apply the non-linear method of estimations. Hence, in this study, we apply the non-linear ARDL cointegration approach for the analysis. Thirdly, FDI has diverse implications for mortality and may vary in the short-run and long-run implications; therefore, it is essential to know the short-run and long-run implications of RE, mortality, and AAP. Hence, non-ARDL method provides the short run and long estimations. The rest of the paper is organized as the second section contains FDI inflow, environment, and mortality in China; Section 3 contains the methodology and data; Section 4 is the result and discussion; and Section 5 presents the conclusion of study.

FOREIGN DIRECT INVESTMENT INFLOW, ENVIRONMENT, AND HUMAN MORTALITIES IN CHINA

This section illustrates the stylized facts like AAP, FDI inflow, and human mortalities for the different periods, which help to understand the time series trend of these variables over the period.

Figure 1 shows the relationship between FDI and AAP. China is receiving the highest share in FDI throughout the world. The graph shows that China has received the highest GDP from 1992 to 1994, but FDI exhibited a declining trend from 1994 to 2001. Recovery in FDI was made from 2002 to 2008. A decline is seen in FDI from 2012 to 2016. Although the pattern of FDI from 1990 to 2016 is not constant, it has shown considerable growth relative to the United States and India. There is a considerable disparity in FDI distribution stock across China. Asian countries contributed a large inflow of FDI in China, followed by North American and European Union countries. China is among the

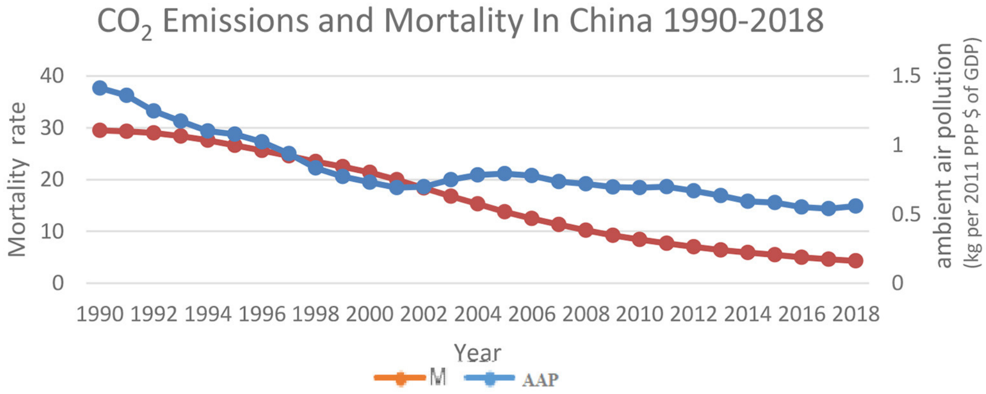

FIGURE 2 | Ambient air pollution and mortality.

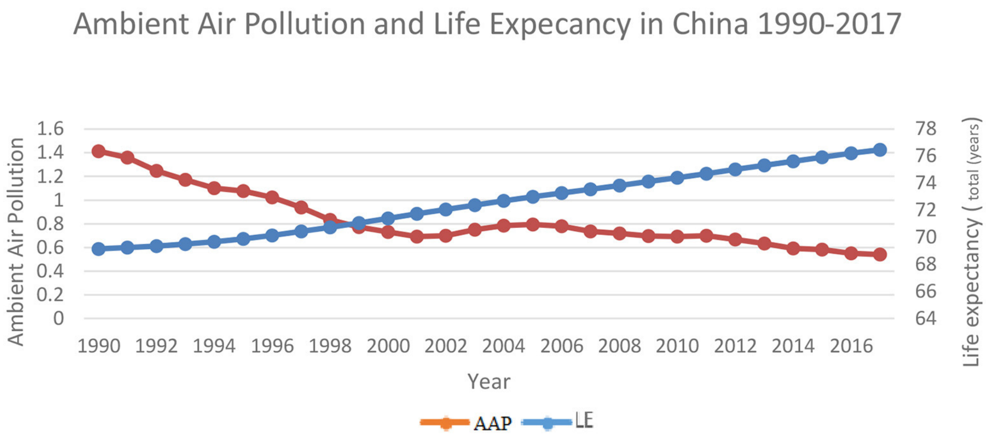

FIGURE 3 | Ambient air pollution and life expectancy.

large polluting countries with increasing foreign and domestic trade and industrial production. Industrial manufacturing is the main source of air and water pollution in China. The graph shows that although FDI is showing a considerable amount of variation in the period of the study, AAP is almost showing a steady position from 2000 to 2016 and overall, AAP shows an increasing trend and the level of FDI also increases over time, suggesting that FDI inflow increases the AAP, which resultantly affects the health.

Figure 2 shows the graphical representation of AAP and mortality rate in China from 1990 to 2018. To achieve higher growth in the economy and remain more competitive in the global market, environmental and air pollution concerns have been sidelined despite the ever-increasing pressure from the international environmental protection agencies. AAP is the main indicator for air quality is, also causing big hazards to health-related issues, such as mortality rate. The **Figure 2** shows that although AAP has decreased from 1990 to 2000, it has shown an increase from 2000 to 2006, and then AAP is showing almost a steady, but the slightly downward position from 2006 to 2018. Concerning AAP, the mortality rate in China has been steadily decreasing at a fast rate from 2002 to 2018. This signifies that as AAP decreases, the mortality rate also tends to decrease in the same direction in China.

Further, it is concluded that the mortality rate has been significantly reduced in China due to lower levels of CO_2 emissions. **Figure 3** shows the pattern of AAP and life expectancy in China from 1990 to 2018. However, China has achieved the highest economic growth and FDI inflow, relatively higher to most North American, Asian, and European countries. This higher economic growth is causing problems to health issues and air quality in most countries. Unlike other developed countries, China exhibits a negative relationship between AAP and life expectancy. The AAP in China has decreased from 1990 to 2000, but it has increased from 2000 to 2006. After 2006, AAP in China is showing a steady position. Relative to AAP in China, life expectancy is increasing from 1990 to 2018, and it shows an increase in health standards due to the lower amount of AAP. The overall trend suggests that life expectancy has been significantly increased due to environmental quality, caused by lower levels of AAP in China over the period.

METHODOLOGY

The model of the study is as:

$$HM_t = \beta_0 + \beta_1 AAP_t + \beta_2 RE_t + \beta_3 FDI_t + \mu_t \qquad (1)$$
$$\mu_t \sim \text{n.i.i.d}(0, \sigma^2)$$

Where,

HM, Mortality index;
AAP, Ambient air pollution;
FDI, Foreign direct investment;
RE, the renewable energy;
μ, Normally distributed error term.

In this study, we use mortality index (HM) as the dependent variable, which is constructed taking "life expectancy," "infant mortality and death rate" variables. AAP, FDI and RE are taken as independent variables. There is a positive relationship between Mortality and AAP in the literature; thus, the expected sign of $\beta_1$is positive. Mortality and foreign direct investment are positively related in literature, and the expected sign of the β_2 is also positive. However, there is a negative relationship between mortality and RE, and the expected sign of coefficient $\beta_3$is negative. Equation (1) is used to estimate the long-run relationship among the variables if cointegration exists. In the given study, short-run estimates are desirable, and short-run parameters and speed of adjustment toward equilibriums can be obtained through Equation (2) as given below.

$$\Delta HM_t = \beta_0 + \sum_{i-1}^{n1} \beta_{1i} \Delta HM_{t-1} + \sum_{i-0}^{n2} \beta_{2i} \Delta AAP2_{t-1} + \sum_{i-0}^{n3} \beta_{3i} \Delta FDI_{t-1} + \sum_{i-0}^{n4} \beta_{4i} \Delta RE_{t-1} + \lambda e_{t-1} + \mu_t \qquad (2)$$

The above equation shows the cointegration relation among the variables, and if it confirms, then any change in equilibrium and a movement will be adjusted and observed. The coefficient "e_{t-1}," i.e., λ sign must be negative and significant as well less than one. All the variables are of the order I (1), and the stationary of the unit root should be I (0) by (55). ARDL methodology is suggested by (56) and (57) if the order of the variable is different and by replacing. The e_{t-1} in Equation 2 can be written as follows:

$$\Delta HM_t = \rho_0 + \sum_{i-1}^{n1} \rho_{1t} \Delta HM_{t-1} + \sum_{i-0}^{n2} \rho_{2t} \Delta AAP_{2t-1} + \sum_{i-0}^{n3} \rho_{3t} \Delta FDI_{t-1} + \sum_{i-0}^{n4} \rho_{4i} \Delta RE_{t-1} + \rho_5 P_{t-1} + \rho_6 AAP_{2t-1} + \rho_7 FDI_{t-1} + \rho_8 RE_{t-1} + \mu_t \qquad (3)$$

In Equation (3), the parameters ρ_5, ρ_6, ρ_7, and ρ_8 are the long-run parameters, whereas short-run parameters are the coefficient having different operator "Δ". Akaike information criterion is used for lag length selection.

Most past studies consider CO_2, FDI, and RE as linear variables, which is unrealistic. Therefore, there is deviation among these variables and does not follow the conventional linear trend and using a linear form of these variables may provide an accurate estimation. The non-linear behavior or asymmetric variables may provide reliable and realistic findings. Thus, asymmetric non-linear captures the dynamic behavior of the variables and provides a short-run and long-run relationship among the variables. We use Shin et al. (58) method of non-linear ARDL estimation method. To investigate both short- and long-run asymmetric impacts of FDI, RE, AAP on mortality, we decomposed AAP, FDI, and RE into positive and negative partial sums as given:

$$AAP_{2t}^{+} = \sum_{j-1}^{t} \Delta AAP_{2j}^{+} = \sum_{j-1}^{t} \max(\Delta AAP_{2j}, 0)$$

$$AAP_{2t}^{-} = \sum_{j-1}^{t} \Delta APP_{2j}^{-} = \sum_{j-1}^{t} \min(\Delta AAP_{2j}, 0)$$

$$FDI_t^{+} = \sum_{j-1}^{t} \Delta FDI_j^{+} = \sum_{j-1}^{t} \max(\Delta FDI_j, 0)$$

$$FDI_t^{-} = \sum_{j-1}^{t} \Delta FDI_j^{-} = \sum_{j-1}^{t} \min(\Delta FDI_j, 0)$$

$$RE_t^{+} = \sum_{j-1}^{t} \Delta RE_j^{+} = \sum_{j-1}^{t} \max(\Delta RE_j, 0)$$

$$RE_t^{-} = \sum_{j-1}^{t} \Delta RE_j^{-} = \sum_{j-1}^{t} \min(\Delta RE_j, 0)$$

Ambient air pollution is decomposed into positive and negative AAP; in the same way, foreign direct investment and RE are converted into positive and negative. This decomposition shows an increase and decrease in each variable. According to Granger, if there are positive and negative two-time series, they are cointegrated. The linear cointegration, which shows the long-run association among the variables, can be converted into linear cointegration. To test the asymmetric relationship among the variables, the testing procedure of the bond test given by Pesaran et al. (57) provides the formwork to find out. Equation (4) shows the asymmetric relationship as follow:

$$\Delta HM_t = \gamma_0 + \sum_{i-1}^{n1} \gamma_{1i} \Delta HM_{t-1} + \sum_{i-1}^{n2} \gamma_{2i} \Delta AAP_{t-1}^{+} + \sum_{i-1}^{n3} \gamma_{3i} \Delta AAP_{t-1}^{-} + \sum_{i-1}^{n4} \gamma_{4i} \Delta FDI_{t-1}^{+} + \sum_{i-1}^{n5} \gamma_{5i} \Delta FDI_{t-1}^{-} + \sum_{i-1}^{n6} \gamma_{6i} \Delta RE_{t-1}^{+} + \sum_{i-1}^{n7} \gamma_{7i} \Delta RE_{t-1}^{-} + \gamma_8 HM_{t-1} + \gamma_9 AAP_{t-1}^{+} + \gamma_{10} AAP_{t-1}^{-} + \gamma_{11} FDI_{t-1}^{+} + \gamma_{12} FDI_{t-1}^{-} + \gamma_{13} RE_{t-1}^{+} + \gamma_{14} RE_{t-1}^{-} + \mu_t \qquad (4)$$

This equation contains both positive negative components of included variables in the model, which comprises both lagged and differenced values. The lagged values will provide the long-run estimation, while the differenced form of the variables will provide a short-run estimation. We used time-series data for all variables from 1990 to 2020 obtained from the world bank database online.

Hypothesis

H0: FDI Does Not Affect Mortality

Many researchers have investigated the nexus between FDI and mortality, and these studies evidenced mixed findings. Hitam and Borhan (9) confirmed that FDI inflow increases the health cost of the host country and increases the death and mortality rate. In a similar study by Kahouli et al. (59) assert that FDI inflow mainly in industrial production with heavy usage of hydro technologies enhances the mortality index of the host country. Many other studies also declared a positive linkage between FDI and mortality (19, 24). We test this hypothesis by applying non-linear ARDL estimation techniques.

H0: Ambient Air Pollution Does Not Affect Mortality

Many previous empirical studies have discussed the relationship between pollution and mortality. The majority of the studies found a positive causal relationship between ambient air pollution and mortality. Afroz et al. (60) argue that air pollution is the main cause of various respiratory problems that directly affect mortality by fostering diseases of lungs, eyes, nose, mouth, and throat, causing asthma attacks and related other serious health issues that badly affect the mortality. Fine particulate emissions from burning coal, oil, diesel fuel, gasoline, and wood can lead to respiratory problems and cancer (61, 62). Many researchers also report negative long-run causality between air pollution and mortality (63). We consider the Granger causality test for empirically testing this hypothesis.

H0: Renewable Energy Does Not Affect Mortality

Renewable energy is a recent area of debate among researchers across the globe. Many studies in this regard have signified its importance. In recent years, RE has remained an area of central focus. In many environmental studies, the usage of RE stands vital for the substantial environmental impacts, which causes a decline in the death mortality rates in infants (64). The heat generated from RE is comparatively health-friendly. Kaygusuz (65) and Walker et al. (66) argue that projects run through RE options would not affect the health of residents adversely and will not cause an increase in the health cost of a nation. We apply the Granger causality test to predict the relationship between these two variables of interest.

RESULTS AND DISCUSSIONS

This section presents the empirical estimation of the model. **Table 1** presents the augmented dicky fuller (ADF) unit root results.

Table 1 presents unit root results. The unit root is tested to check the non-stationary at the level and become stationary at first difference. The order of the autoregressive distributed lag model (ARDL) framework does not follow the same order of integration; this implies that cointegration estimation performs even if the variables have a mixed order of integration.

TABLE 1 | ADF unit root.

Variables	At level	At difference	Order of integration
HM	−1.282773	−5.299412***	I(1)
FDI	−1.997471	−4.33117***	I(1)
RE	−1.797604	−6.683807***	I(1)
AAP	−1.849559	−4.552002***	I(1)

****Shows significance at 1%.*

TABLE 2 | Short-run estimations.

Variables	Coefficient	T-statistics
AAP(-1) +	8.485551	2.66
AAP(-1) -	−4.965234	−3.96
RE(-1) +	−0.8297197	−4.00
RE(-1) -	0.0981809	3.98
FDI(-1)+	−0.0051128	−0.27
FDI(-1) -	0.0793245	1.67
ΔAAP +	10.49173	4.08
ΔAAP -	−6.716407	−2.75
ΔAAP(-1)+	0.2112664	0.38
ΔAAP (-1) -	−2.288925	−2.29
ΔRE +	0.4693659	4.83
ΔRE -	−0.1487219	−2.56
ΔRE(-1) +	−0.2242492	−3.66
ΔRE(-1) -	0.0419803	0.98
ΔFDI+	−0.0373433	−2.65
ΔFDI -	0.0617111	2.34
ΔFDI(-1)+	−0.1113837	−1.47
ΔFDI(-1) -	−0.1877629	−3.68
ECT(-1)	−0.9033187	−3.22

The second step is to perform the short-run estimations. **Table 2** presents the error correction model outcomes. Error correction term (ECT_{-1}) is found a negative and significant association, implying the existence of convergence toward long-run equilibrium and the coefficient sign of ECT is negative and significant which that model is converging long-run equilibrium shortly. The short-run parameters comprise positive and negative shocks; positive shocks of the AAP increase mortality, while negative shock decreases mortality. This implies the asymmetric behavior of the AAP with mortality, implying a positive association. The other variable like RE shows that positive shocks reduce mortality, while negative shows have positive implications for mortality. This implies a negative association between mortality and mortality. The FDI inflow shows positive shocks increase mortality while negative shocks increase mortality, indicating a negative association between mortality and FDI. Or in other words, this shows that FDI inflow contributed to AAP, which affected human and health and mortality in the short run.

Table 3 presents the long-run effect that indicates the positive and negative shocks for the included variables in the model. The positive shock of the AAP increases mortality by 9.39 per capita,

TABLE 3 | Long-run estimations.

Variables	Long effect [+]			Long effect [-]		
	Coefficient	F-statistics	P > F	Coefficient	F-statistics	P > F
AAP	9.394	21.22	0.006	−5.497	22.33	0.005
RE	−0.919	8.988	0.030	0.109	16.59	0.010
FDI	0.006	4.6491	0.080	−0.088	3.386	0.079
	Long-run asymmetry			Short-run asymmetry		
	F-stat	P > F		F-stat	P > F	
AAP	24.68	0.004		20.39	0.006	
RE	9.583	0.027		12.55	0.017	
FDI	4.689	0.081		5.277	0.070	

TABLE 4 | Bound test.

Lower bound (0)	Upper bound (1)	F- Statistics	Conclusion
2.32	3.752	5.36	F-values exceeds from upper bound, which means the existence of cointegration
Model diagnostics		**Stat.**	***p*-value**
Portmanteau test up to lag 40 (chi2)		17.86	0.0850
Breusch/Pagan heteroskedasticity test (chi2)		0.2506	0.6166
Ramsey RESET test (F)		0.415	1.2600
Jarque–Bera test on normality (chi2)		0.6466	0.7238

which is significant at one percent level. In comparison, negative shock reduces mortality by 5% at 1% level of significance. The positive shock of RE negatively affects mortality as each one-unit increase in RE reduces mortality by 0.9, while negative shock increases mortality by 0.08 unit at 1% level of significance. The positive shocks of FDI inflow decrease health quality by 0.006 at 10 percent significance level, while negative shocks increase health quality by 0.08. The long-run asymmetric statistics point toward asymmetric behavior of AAP, RE, and FDI, which implies the existence of non-linearity in the model. **Table 4** contains the bound test results that reported that F-statistics values exceed the upper bound of critical value, suggesting the existence of a long-run relationship among the variables, such as FDI inflow, AAP, mortality, and RE. Besides, the lower part of **Table 4** shows diagnostic test outcomes, suggesting that the cointegration test is valid for the model suggested by model diagnostic results. Breusch–Pagan test shows no issue of heteroscedasticity in the model. The Ramsey RESET test (F) shows no specification problem in the model.

Robustness Test

We used a robustness test to verify the baseline outcomes further. **Table 5** presents the causality analysis results showing that unidirectional causality from FDI to AAP implies that FDI inflow increases the FDI inflow in the country. There is bi-directional causality between ambient air pollution and HM. This implies that AAP cause HM. There is also a unidirectional from RE to HM. This implies that RE causes the mortality. The results of this study are in line with the previous literature as most of the previous studies confirmed the positive association between FDI and pollution, explaining that More FDI to a host country increases the air pollution in the host country Alsan et al. (20); Nagel et al. (23). Furthermore, Hitam and Borhan (9) suggest that an adverse effect of FDI on health and reported that FDI inflow leads to an increase in the health cost in the host country. Similarly, the results of this study confirm the previous literature findings such as Walker et al. (66); Kaygusuz (65) confirmed that RE consumption may lower the mortality and a positive association has been found between FDI and health quality.

TABLE 5 | Granger causality tests.

Pairwise Granger Causality Tests		
Null Hypothesis:	**F-Statistic**	**Prob.**
FDI does not Granger Cause AAP	5.09776	0.0157
AAP does not Granger Cause FDI	0.45058	0.6433
HM does not Granger Cause AAP	2.74913	0.0870
AAP does not Granger Cause HM	6.09241	0.0082
RE does not Granger Cause AAP	1.46295	0.2542
AAP does not Granger Cause RE	2.68877	0.0913
HM does not Granger Cause FDI	0.6521	0.5312
FDI does not Granger Cause HM	4.18383	0.0296
RE does not Granger Cause FDI	4.13318	0.0307
FDI does not Granger Cause RE	0.07777	0.9254
RE does not Granger Cause HM	4.01115	0.0299
HM does not Granger Cause RE	3.15180	0.1412

CONCLUSION

Foreign direct investment inflow is generally considered with a positive effect on the economy, supported by various empirical studies. Nonetheless, the FDI imposes a serious cost, particularly on the environment, in terms of AAP, which leads to mortality. Therefore, this paper investigates the relationship between FDI inflow, AAP, mortality, and RE in China from 1998 to 2020. China takes various reforms to boost FDI inflow, which has brought a significant amount of FDI in the country in the last few decades. This study uses a non-linear ARDL cointegration approach for the empirical analysis; we use mortality as a dependent variable while RE, FDI inflow, and AAP as independent variables. The empirical findings suggest the long-run and the short-run association between mortality, FDI inflow, RE, and AAP. The results also support the existence of both short-run and long asymmetries in the model, which implies explanatory variables are held an asymmetric relationship with the dependent variable. The short-run findings present mixed results, while long-run findings show a positive effect of FDI inflow and AAP on mortality, while RE found negatively associated with mortality. The Granger causality results further support the baseline estimation as FDI and AAP and RE causes mortality. Similarly, AAP causes mortality. These findings suggest that FDI has the main component of AAP, indicating that FDI inflow causes AAP in China. Besides, we also confirm that AAP is the main source of morality in China. Thus, FDI could lead to mortality in China.

Moreover, the negative association between human mortality suggests that FDI could reduce human morality by providing the environment's quality and meeting the energy needs of country. The government needs proper policy guidelines to further boost up FDI inflow due to its positive aspects. However, to reduce AAP and human morality, more RE options should be adopted in various foreign own enterprises. Furthermore, proper legislation for foreign firms might be a good step toward environmental and human health qualities. This study can be extended to many other developed countries by conducting a comparative study. A similar study can also be conducted comparing the Southeast countries. A study can be a wise attempt if India is compared with China using the same variables explored.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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