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Supplementary Materials: Inequalities in $PM_{2.5}$ and SO_2 Exposure Health Risks in Terms of Emissions in China, 2013–2017

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1. Definition of Health Risk Inequality Curve (HRICU) and Health Risk Inequality Coefficient (HRICO)

In economics, the Lorenz curve is a curve consisting of the percentage of population and the percentage of income within an aggregate (e.g., within a country or a region), from the "poorest population to the richest population", and is often used together with the Gini coefficient to analyze the fairness of social wealth. In this study, to analyze the issue of equity in the distribution of premature deaths due to air pollutant exposure on emissions, we created a health risk inequality curve (HRICU) and a health risk inequality coefficient (HRICO) based on the concepts of Lorenz curve and Gini coefficient, based on the analysis of equity in the distribution of premature deaths on GDP in the study by Liu et al. [1]. In this study, to analyze the fairness of the distribution of premature death in air pollutant emissions, the HRICU is plotted based on the percentage of population from the "poorest to the richest population in terms of emissions" and the corresponding percentage of premature deaths (Figure S1), and the the slope of the HRICU is the premature mortality rate (premature deaths/total population) at the corresponding point. When the HRICU is a straight line through the origin and the (1,1) point, the premature mortality rate does not change regardless of the emission scenario, and premature human deaths are considered to be unaffected by changes in emissions, which means to be absolutely fair in terms of emissions (black line in Figure S1).

According to Liu et al. [1], the HRICU may appear concave or convex or both concave and convex together. When part or all of the HRICU is concave (Figure S1a) or convex (Figure S1b), it indicates that the emissions will affect the premature mortality, which is manifested in the concave part of the population as high premature mortality in the population with high emissions and in the convex part of the population as high mortality in the population with low emissions, both of which depart from the goal of absolute equality of premature mortality in all populations, and an inequitable distribution of premature mortality occurs with differences in pollutant emissions in the population. The higher mortality rates in low-emission areas may be due to high levels of locally imported exogenous pollution, resulting in higher air pollution, rather than originating from internal emissions.

To measure the magnitude of equity in the distribution of premature mortality over populations with different emission levels, we developed the health risk inequality factor (HRICO) based on the concept of the Gini coefficient. HRICO characterizes the degree of HRICU departure from the absolute equality line by calculating the area between HRICU and the absolute equality line; the greater the degree of departure, the greater the HRICO and the greater the inequity.

Since there is still no evidence to fully explain the relationship between emissions and premature mortality, and, thus, it is not possible to determine the reasonable (practical fairness) premature mortality rate corresponding to a certain emission, this study defines the reasonable (fair) premature mortality rate corresponding to each emission as 0%, so that the under or over premature mortality under a certain emission is the number of premature mortalities itself. Since this study focuses on the inequitable comparison of

premature mortality rates between China and Chinese provinces at emissions, the results of this study are still convincing even with the inclusion of the above assumptions.

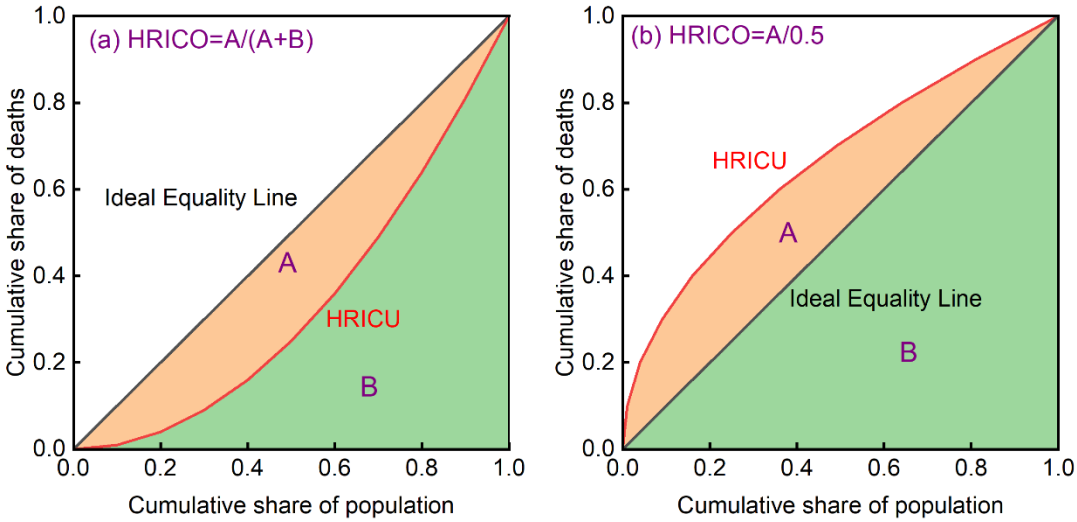

Figure S1. Definition of HRICU and HRICO. A is the area between the Lorentz curve and the ideal equality line. B is the area between the Lorentz curve and the coordinate axis.

2. National HRICU for $PM_{2.5}$ and SO_2

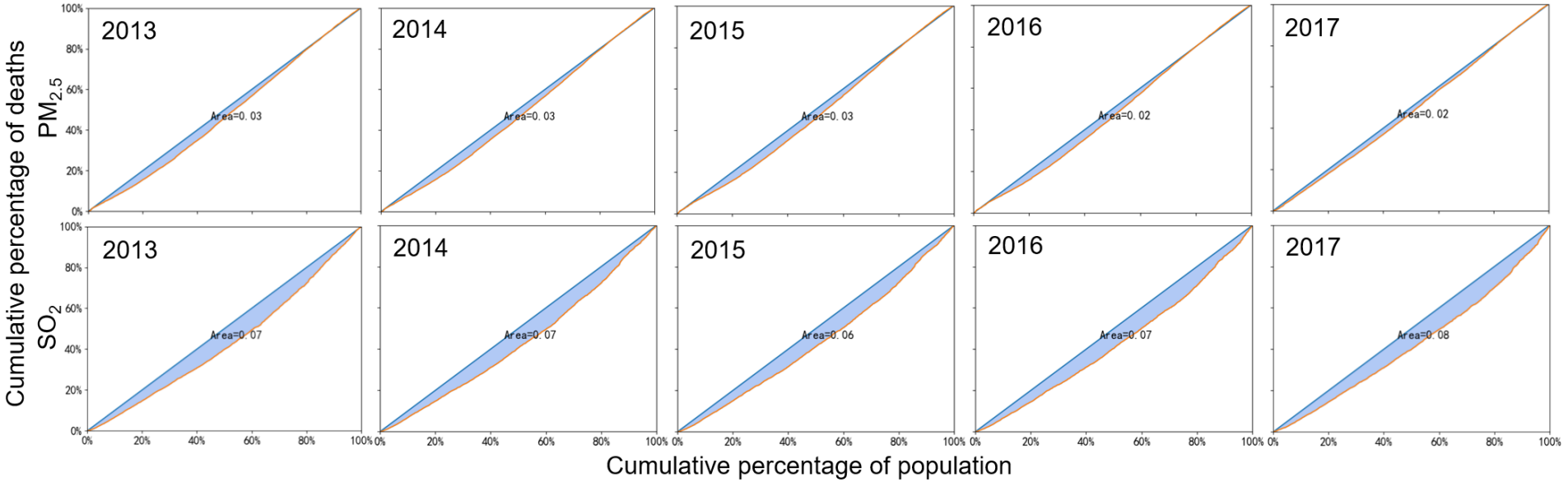

Figure S2. National HRICU for $PM_{2.5}$ and SO_2 from 2013 to 2017. The red line is HRICU, and the black line is the ideal equality line.

3. HRICO for Each Province

Table S1. The HRICO of $PM_{2.5}$.

Province	2013	2014	2015	2016	2017
Beijing	0.04	0.04	0.05	0.06	0.03
Tianjin	0.01	0.01	0.01	0.01	0.02
Hebei Province	0.03	0.02	0.02	0.02	0.03
Shanxi Province	0.03	0.03	0.02	0.03	0.04
Inner Mongolia Autonomous Region	0.03	0.04	0.03	0.04	0.1
Liaoning Province	0.04	0.04	0.04	0.03	0.06
Jilin Province	0.06	0.06	0.06	0.05	0.06
Heilongjiang Province	0.06	0.05	0.07	0.09	0.07
Shanghai	0	0.01	0.01	0.01	0.01
Jiangsu Province	0.01	0.01	0	0.01	0.01
Zhejiang Province	0.06	0.06	0.06	0.05	0.04
Anhui Province	0.01	0.01	0.01	0.01	0.01
Fujian Province	0.01	0.01	0.01	0.01	0.03
Jiangxi Province	0.04	0.05	0.04	0.04	0.05
Shandong Province	0.04	0.03	0.03	0.03	0.02
Henan Province	0.02	0.02	0.03	0.03	0.03
Hubei Province	0.03	0.01	0.01	0.01	0.03
Hunan Province	0.05	0.05	0.04	0.04	0.06
Guangdong Province	0.01	0.01	0.01	0.01	0.04
Guangxi Zhuang Autonomous Region	0.03	0.03	0.03	0.03	0.05
Hainan Province	0.01	0.01	0.02	0.02	0.02
Chongqing	0.05	0.04	0.04	0.03	0.06
Sichuan Province	0.05	0.03	0.02	0.02	0.08
Guizhou Province	0.02	0.02	0.02	0.02	0.03
Yunnan Province	0.04	0.04	0.04	0.04	0.05
Tibet Autonomous Region	0.14	0.14	0.19	0.21	0.12
Shaanxi Province	0.03	0.04	0.03	0.05	0.05
Gansu Province	0.02	0.02	0.02	0.03	0.04
Qinghai Province	0.13	0.13	0.14	0.14	0.15
Ningxia Hui Autonomous Region	0.03	0.05	0.03	0.02	0.05
Xinjiang Uygur Autonomous Region	0.05	0.03	0.02	0.02	0.05

Table S2. The HRICO of SO_2.

Province	2013	2014	2015	2016	2017
Beijing	0.06	0.04	0.03	0.03	0.08
Tianjin	0.1	0.08	0.08	0.06	0.07
Hebei Province	0.03	0.02	0.01	0.02	0.04
Shanxi Province	0.02	0.02	0.03	0.03	0.04
Inner Mongolia Autonomous Region	0.05	0.04	0.06	0.06	0.06
Liaoning Province	0.08	0.08	0.07	0.07	0.05
Jilin Province	0.09	0.08	0.07	0.06	0.07
Heilongjiang Province	0.06	0.1	0.07	0.05	0.08
Shanghai	0.12	0.06	0.06	0.08	0.1
Jiangsu Province	0.08	0.07	0.08	0.06	0.05
Zhejiang Province	0.02	0.03	0.03	0.03	0.02
Anhui Province	0.02	0.04	0.04	0.03	0.02
Fujian Province	0.1	0.08	0.1	0.07	0.06
Jiangxi Province	0.08	0.05	0.06	0.04	0.05
Shandong Province	0.02	0.02	0.01	0.01	0.02
Henan Province	0.07	0.05	0.05	0.07	0.08
Hubei Province	0.08	0.05	0.03	0.01	0.01
Hunan Province	0.06	0.04	0.03	0.05	0.06
Guangdong Province	0.02	0.03	0.04	0.05	0.04
Guangxi Zhuang Autonomous Region	0.02	0.02	0.03	0.02	0.02
Hainan Province	0.22	0.26	0.27	0.15	0.15
Chongqing	0.11	0.06	0.03	0.02	0.03
Sichuan Province	0.06	0.04	0.03	0.02	0.03
Guizhou Province	0.02	0.02	0.03	0.03	0.02
Yunnan Province	0.02	0.01	0.01	0.02	0.01
Tibet Autonomous Region	0.08	0.08	0.09	0.09	0.11
Shaanxi Province	0.09	0.06	0.05	0.06	0.05
Gansu Province	0.04	0.03	0.02	0.01	0.02
Qinghai Province	0.07	0.07	0.04	0.06	0.04
Ningxia Hui Autonomous Region	0.15	0.15	0.15	0.17	0.16
Xinjiang Uygur Autonomous Region	0.1	0.11	0.2	0.15	0.07

Reference

1. Liu, M.; Saari, R.K.; Zhou, G.; Li, J.; Han, L.; Liu, X. Recent Trends in Premature Mortality and Health Disparities Attributable to Ambient PM2.5 Exposure in China: 2005–2017. *Environ. Pollut.* **2021**, *279*, 116882, doi:10.1016/j.envpol.2021.116882.