**Supporting Information for**

# Mismatched social welfare allocation and $PM_{2.5}$-related health damage along value chains within China

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## Supporting Information Text

### Uncertainty analysis on health impact assessment

An uncertainty analysis of $PM_{2.5}$-related mortality and morbidity was conducted in this study. Limited to the available data, we referred to two different studies[1,2] with slightly different calculation functions to calculate the $PM_{2.5}$-related mortality and morbidity separately. The parameters of exposure-response coefficient and baseline concentration setting were the focus of uncertainty analysis here.

For the estimation of $PM_{2.5}$-related mortality, the updated integrated exposure–response functions[1] were applied, and the impact could be calculated as follows,

$$\mathrm{Y} = \mathrm{Y_0}\left(1 - \frac{1}{\mathrm{RR}}\right)\mathrm{Pop} \tag{1}$$

$$\mathrm{RR(z)} = 1 + \alpha\left(1 - \mathrm{e}^{\beta(z - z_{cf})^{\gamma}}\right) \tag{2}$$

where $\mathrm{Y_0}$ is the baseline incidence rate, Pop means the exposed population, RR denotes the relative risk for specific health endpoint, z and $z_{cf}$ represent the concentration of $PM_{2.5}$ and theoretical minimum risk exposure level, and $\alpha$, $\beta$, and $\gamma$ are parameters. $\beta$ is the ratio of the integrated exposure–response functions at low to high concentrations. $\beta$ was provided for every interval of $PM_{2.5}$ concentration levels from 0 to infinity. The data sources remain the same with previous work[3]. Referring to the posterior distributions of parameters from Cohen et al.[1], we applied the Monte Carlo method to repeat 10000 times calculations, obtaining the possibility distribution of mortality triggered by $PM_{2.5}$ exposure and confidence intervals of results (Fig. S1a).

For the estimation of $PM_{2.5}$-related morbidity, we applied a log-linear exposure-response function[2] to estimate four health endpoints of morbidity as follow,

$$\mathrm{HI} = \mathrm{Pop} \times (\mathrm{Y} - \mathrm{Y_0}) \tag{3}$$

$$\mathrm{Y} = \mathrm{Y_0} \times \mathrm{e}^{\beta(\mathrm{C} - \mathrm{C_0})} \tag{4}$$

where HI represents the morbidity under $PM_{2.5}$ concentration level C, $\mathrm{Y_0}$ is the baseline incidence rate, $\beta$ is the exposure-response coefficients denoting the incidence change of certain health impact per μg m$^{-3}$ $PM_{2.5}$ increment; $C_0$ is the baseline $PM_{2.5}$ concentration. Obviously, the formula for morbidity estimation is cruder compared to the calculation of mortality, and $\beta$ is set singularly for each health ending, without specific values for the different concentration intervals. Similarly, we obtained the confidence intervals (Table. S1) of $\beta$ from Hao et al.[2] and conducted Monte Carlo method by simulating 10,000 cases with randomly chosen parameter (Fig. S1b).

According to the uncertainty analysis of exposure-response coefficient, national value chain induced 146.9—197.7 thousand people of mortality (95% confidence interval), 3.6—17.9 million people of morbidity (95% confidence interval) of mainland China in 2017, and a total health economic loss of 663.7 billion–886.7 billion CNY (95% confidence interval) (Fig. S1). Uncertainty analysis of health damage at a provincial scale are presented in Fig. S2 and S3.

For the baseline $PM_{2.5}$ concentration $C_0$, we considered WHO recommendation and China national standard for air quality. WHO decreased the recommended annual PM2.5 concentration level from 10 μg m$^{-3}$ in Air Quality Guidelines 2005[4] to 5 μg m-3 in Air Quality Guidelines 2021[5]. The recommendation is made in the interests of health, but it is difficult to reach for some countries, especially for certain developing countries. Regarding China, national class I and II standard for annual $PM_{2.5}$ concentration level[6] is 15 μg m$^{-3}$ and 35 μg m$^{-3}$. However, most of areas in China are far from meeting the class I standard. According to official statistics, the annual average $PM_{2.5}$ concentration level remained 30~43 μg m$^{-3}$ during 2017-2021 period, and only 6.2% of cities reached the class I standard in 2021 according to the annual reports on the state of the ecology and environment published by Ministry of Ecology and Environment of the People's Republic of China. Here, this study estimated the $PM_{2.5}$ exposure related morbidity based on varying levels of the baseline $PM_{2.5}$ concentration: 5, 10, 15 μg m$^{-3}$. The results showed that the baseline $PM_{2.5}$ concentration make little sense to the final conclusion (Table S2), that the upper and lower settings brought about less than $\pm 5\%$ of change in morbidity estimation and $\pm 1\%$ of change in health economic loss. Hence, for simplicity and the minor influence of it, only the results under 10 μg $m^{-3}$ baseline $PM_{2.5}$ concentration level were presented in the main text.

**Uncertainty analysis on value of statistical life**

In this study, we applied the value of statistical life (VSL) to evaluate $PM_{2.5}$ exposure-related health economic loss. Measured by willingness to pay, VSL considers human subjective feelings on the impact of air pollution on health, presenting spatial and temporal disparities, as well as distinctions among different groups of people. It is another source of uncertainty in this study. In Table S3, we present existing VSL original data for mainland China, which has been widely applied in previous studies to quantify the external cost of air pollutant emissions or the health benefit of emission reduction.

To better compare data from different sources, we unified data into the same year and currency as follows [7]:

$$\mathrm{VSL}_t = \mathrm{VSL}_0 \left(\frac{\mathrm{Income}_t}{\mathrm{Income}_0}\right)^e \tag{5}$$

where $VSL_t$ denotes the VSL of year t, $VSL_0$ means the VSL of the base year, $Income_t$ represents the residential disposable income of year t, $Income_0$ means the residential disposable income of the base year, and e means income elasticity.

After the year transfer, significant differences among various VSL data were observed, with high values 26 to 50 times the low values (see Table S4). The VSL of Anqing [8] served as the bottom, while the VSL of Jingzhong [9] and Shanghai/Jiujiang/Nanning [10] was the ceiling when income elasticity was 0.8–1.0 and 1.2-1.6, respectively. Because these data were published for a longer time and great variations were observed in the VSL of one city during the period from 2005 to 2016 [11], we used the most recent results from Cao C et al. [9], which covered six cities across mainland China in this study. We used the average values of these of six cities to evaluate health economic loss.

In addition, income elasticity was used to transfer estimates of VSL between different years, different regions or different income populations. According to Table S4, we find that income elasticity will greatly affect VSL estimates. Here, we conducted a reliability analysis on data from Cao C, et al. [9] to determine the suitable income elasticity, and results show in Table S5 and S6. VSL reflects the present value of the total value of an individual's expected remaining life years. According to Hammitt J. and Robinson L. [7], VSL should be greater than the current value of expected income in the remaining years of life because the utility of life will be greater than the utility of income. When income elasticity > 1.4, VSL was observed lower than expected income in Table S5 (highlighted in red). Therefore, we determined income elasticity to be 1.4 to calculate VSL in 2017, which is also consistent with previous studies [12,13].

**A supplementary analysis on health impact assessment under supply chain variation based on hypothetical extraction method (HEM)**

This study implemented a comprehensive analysis framework with a combination of input-output model, value chain method, the extended response surface model (ERSM) with polynomial functions, and exposure–response functions to explore the regional health impacts in the participation in domestic value chain. In the first module, with aid of input-output model and value chain method, we decomposed the total pollutants emissions into sectoral level across provincial regions along the domestic value chain. In the second module, the pollutants emissions are further incorporated into ERSM and exposure–response functions to estimate the $PM_{2.5}$ exposure related mortality and morbidity. To be specific, the second module calculated the health effects for both the realistic case or baseline case (all pollutants are emitted as was) and the counterfactual case (pollutant emissions due to a trade activity were removed). Then, the health impact of certain trade activity was obtained through subtracting the certain counterfactual case by baseline case. Finally, gathering the impact of every region or sector, we derived the overall uneven distribution of losses and gains across all the regions or sectors along value chain.

Here we used counterfactual to get the difference, so as to evaluate the contribution (or possible proportion) of every region/sector in the value chain. It is equivalent to assuming that, the emissions due to the absence of one region's producing activity is directly removed, and ignores the dynamicity of production network. However, for policy makers of every provincial region, the assumption may bring about overestimation or underestimation on the gains and losses of the region in the participation in production division of labor. For example, some other regions may replace the position of the original one to maintain the normal operation of supply chain, while the partial pollutants may float back to the original region under atmospheric transport.

To improve our original finding and provide a more realistic reference for policy makers, this study attempted to quantitively measure the health impact assessment under a dynamic production network, and compared the results. Based on input-output table, hypothetical extraction method (HEM) is adopted here to single out the entire impact of a certain activity by deleting it in the tables and replacing the extracted one with the others[14]. Specifically speaking, to obtain the impacts of one provincial region when it supplies intermediate or final products in domestic value chain, we deleted the intermediate inputs and final products of it in the intra-regional trade; meanwhile, the deleted intermediate inputs and final products of it were allocated to the corresponding industries of other regions. Obviously, there are two factors determining the variation of the results of HEM and the original one:

1) First, when one region's intermediate inputs coefficients become zero in domestic outflows, its total amount of international export will decrease as well. Thus, its pollutants emission will be lower in such a counterfactual case

enlarging the gap with baseline case. Consequently, the health impact assessed by HEM will be higher than the original one.

2) Second, when the replacement exists in the production network, other provincial regions will undertake more productions and thus emit more pollutants. Under atmospheric transport, the rising emission from others will also induce higher pollution concentration for the target region, shrinking the gap with baseline case. As a result, the health impact assessed by HEM will be lower than the original one.

Results showed that the results by HEM is -19%~7% of the estimates from traditional method (Table S7). It means our original results may underestimate the health impacts by no more than 19% and overestimate by no more than 7%. Herein, if we only consider the second factor (i.e., the replacement effect and the resulting other regions' rising emission), our original results may overestimate the health impacts of every region in its participation in domestic value chain by 0%~23%.

Given to the difficulty to integrate with value chain method and the accompanied more uncertainties of the dynamic system, we remained the current ways to investigate regional health damage in the domestic value chain with supplementing the above analysis as an uncertainty analysis of our results.

## Supporting Information Figures and Tables

**Figure. S1. Uncertainty analysis of PM2.5 exposure-related health damage**

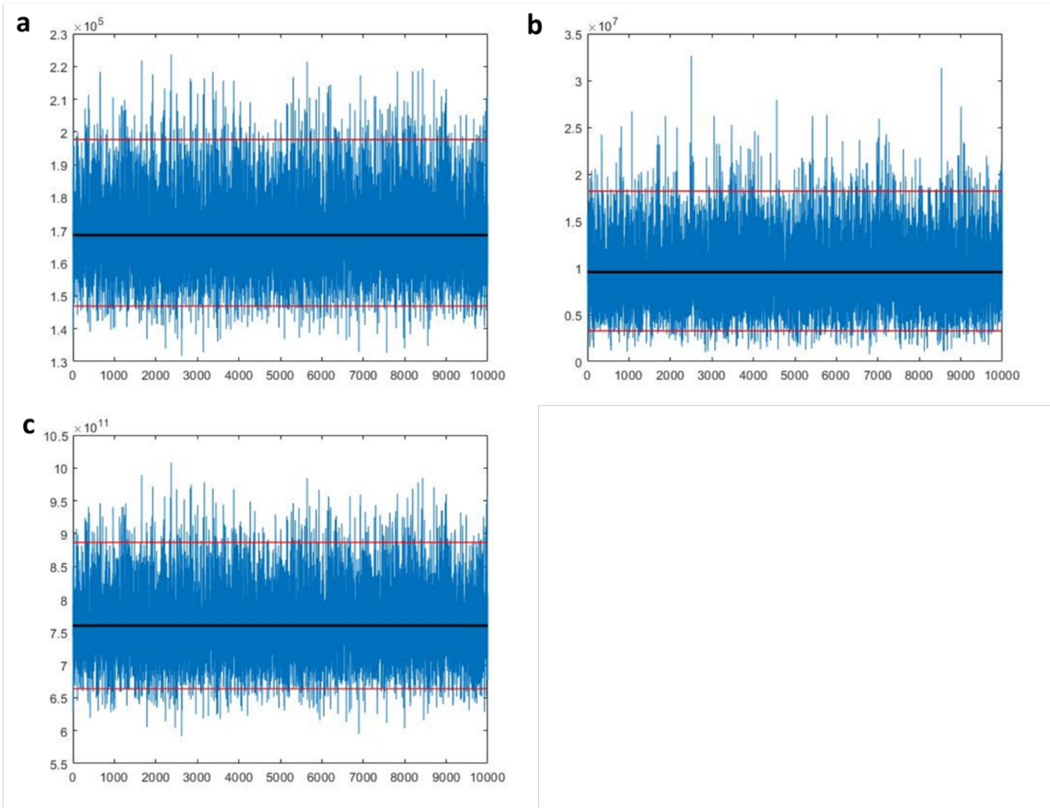



Figure. S1. Uncertainty analysis of $PM_{2.5}$ exposure-related health damage in the national value chain in 2017. a. Total mortality, people; b. Total morbidity, people; c. Total health economic loss, CNY. Note that the morbidity presented here is estimated based on $C_0 = 10$ μg m$^{-3}$.

**Figure. S2. Uncertainty analysis of $PM_{2.5}$ exposure-related mortality**

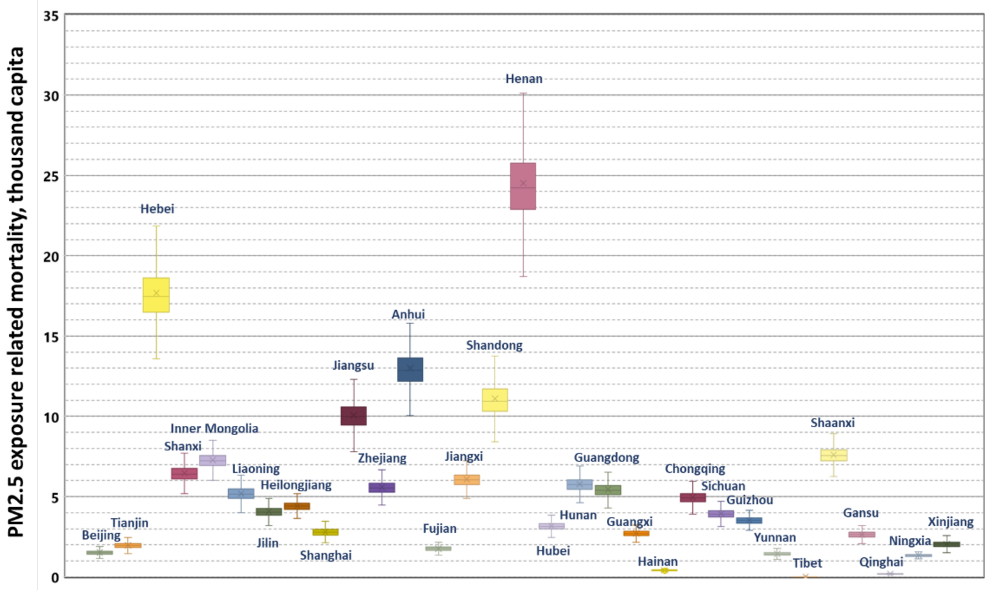



Figure. S2. Uncertainty analysis of $PM_{2.5}$ exposure-related mortality at a provincial scale. The boxplot shows the highest value, 3/4 quartile, average (marked with a cross), 1/2 quartile, 1/4 quartile, and lowest value. Note that the morbidity presented here is estimated based on $C_0 = 10$ μg $m^{-3}$.

**Figure. S3. Uncertainty analysis of $PM_{2.5}$ exposure-related morbidity**

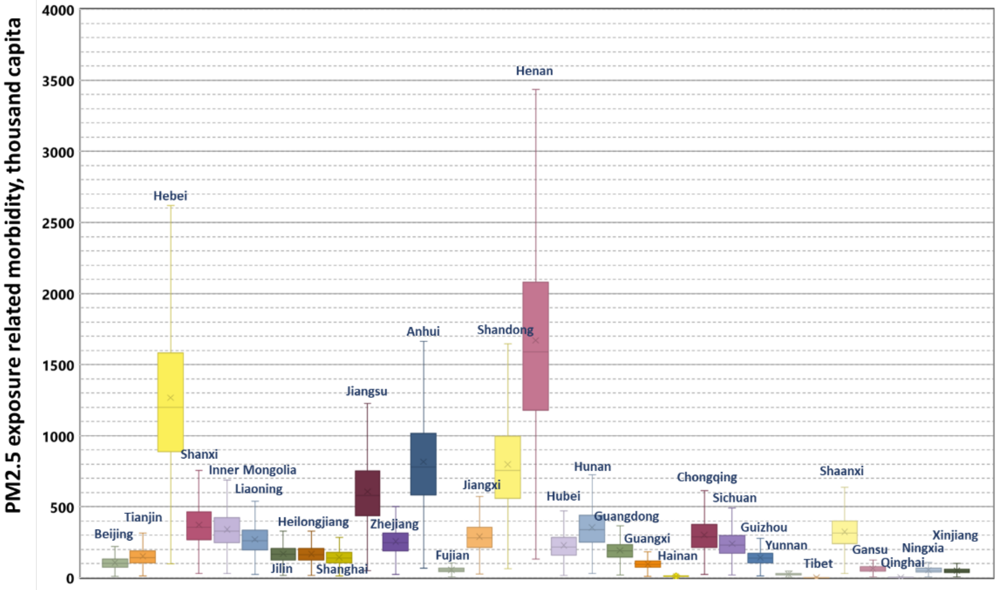



Figure. S3. Uncertainty analysis of $PM_{2.5}$ exposure-related morbidity at a provincial scale. The boxplot shows the highest value, 3/4 quartile, average (marked with a cross), 1/2 quartile, 1/4 quartile, and lowest value. Note that the morbidity presented here is estimated based on $C_0 = 10$ μg $m^{-3}$.

**Figure. S4. The impacts of inter-regional trade on $PM_{2.5}$ concentration variation**

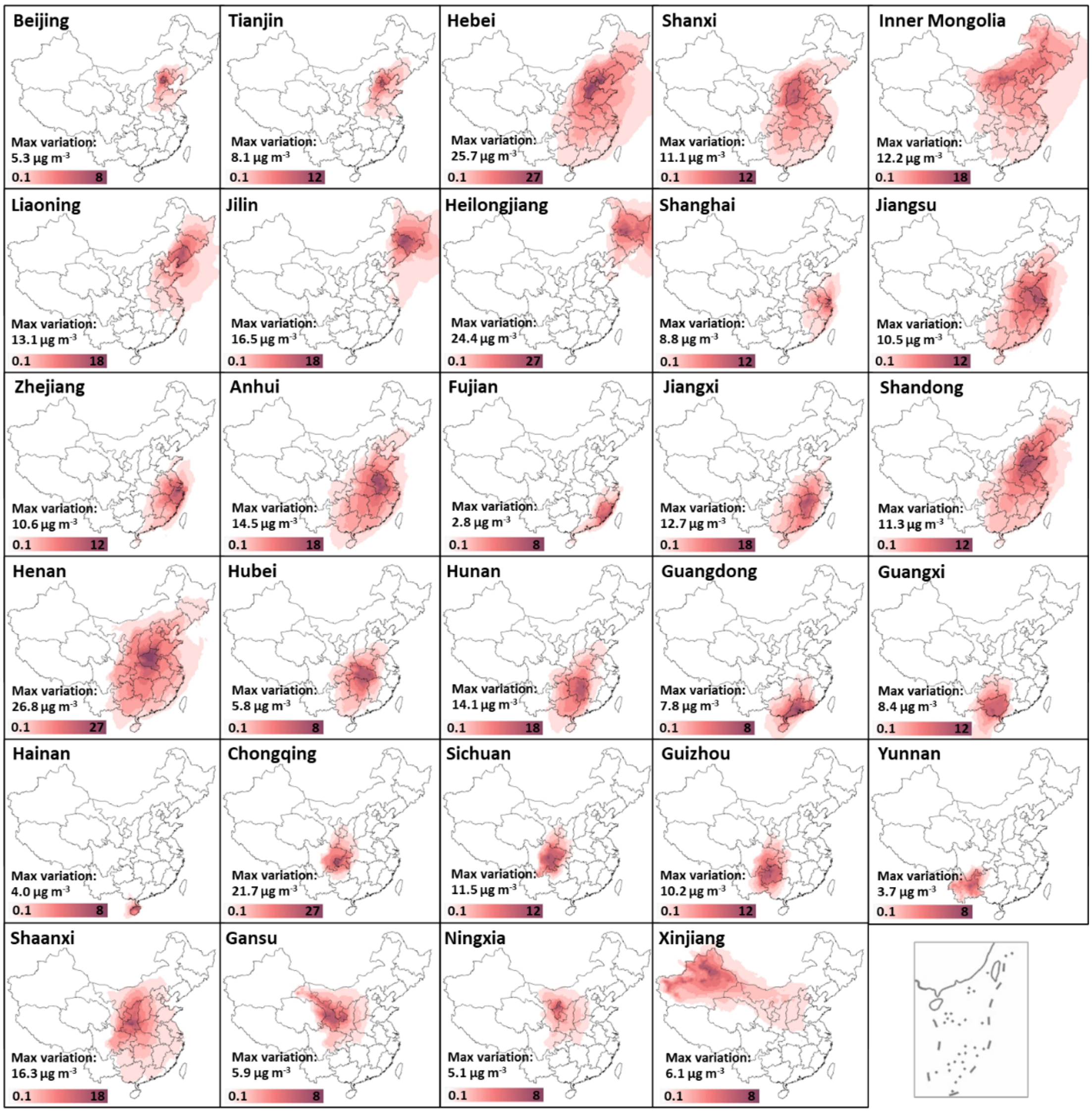
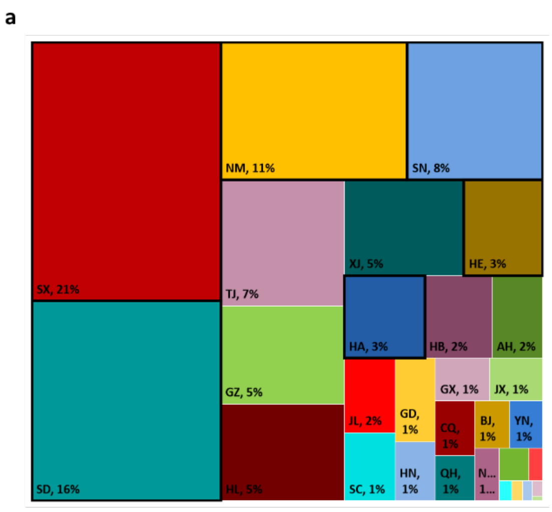



Figure. S4. The impacts of inter-regional trade on $PM_{2.5}$ concentration variations. $PM_{2.5}$ concentration variations mean the differences in $PM_{2.5}$ concentration between basic scenario (the $PM_{2.5}$ concentration of real world) and the others based on hypothesis extraction method (such as the simulated $PM_{2.5}$ concentration when removing emissions of certain activity of one provincial region). The variations to some extend reflect the impacts of certain activity to the $PM_{2.5}$ concentration. Each figure is the influence of one provincial region's emission on the change in $PM_{2.5}$ concentration. Tibet and Qinghai are not presented here, the maximum influences of which were less than 2 μg $m^{-3}$.

**Figure. S5. Contributions to resource product exports in the national value chain**



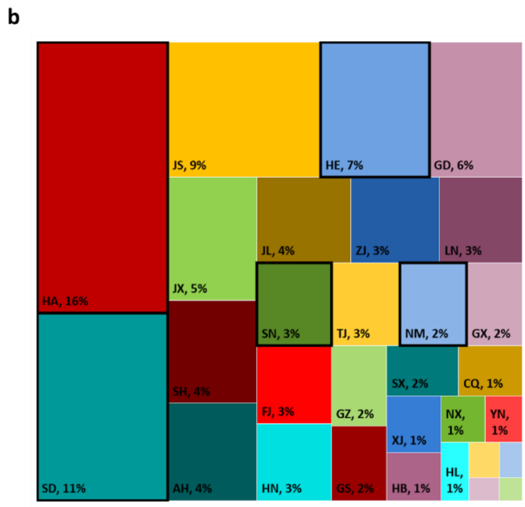




Figure. S5. Contributions to resource product exports in the national value chain. a. Intermediate products of mining industry. b. Intermediate products of the resource processing industry. Provinces in North Central are highlighted by black borders.

**Table S1. $PM_{2.5}$ exposure-response coefficients for each health endpoint**

Table S1. $PM_{2.5}$ exposure-response coefficients for each health endpoint[2]

| Health endpoint | Population | β (CI 95%) |
|---|---|---|
| Morbidity: Chronic bronchitis | All | 2.70E-03 (7.62E-04, 4.64E-03) |
| Morbidity: Cardiovascular (hospital admission) | All | 6.80E-03 (4.30E-04, 9.30E-04) |
| Morbidity: Asthma attack | All | 2.10E-03 (1.45E-03, 2.74E-03) |
| Morbidity: Acute bronchitis | All | 7.90E-03 (2.70E-03, 1.30E-02) |

**Table S2. The health damage of inter-regional trade estimated under varying baseline concentration levels**

Table S2. The health damage of inter-regional trade estimated under varying baseline concentration levels

| | C0=5μg $m^{-3}$ | C0=10μg $m^{-3}$ | C0=15μg $m^{-3}$ |
|---|---|---|---|
| Morbidity, million people | 9.477 | 9.097 | 8.671 |
| Total health economic loss, billion CNY | 761.176 | 760.576 | 759.729 |

**Table S3. Original source and data of VSL**

Table S3. Original source and data of VSL

| Sources (Published year) | Case Place | Case Year | VSL | Unit |
|---|---|---|---|---|
| Johnson T., et al. (1997) [15] | China | 1995 | 60000 | 1995 USD |
| Wang H. and Mullahy J. (2006) [12] | Chongqing | 1998 | 286000 (Median) | 1998 RMB |
| Hammitt J. and Zhou Y. (2006) [8] | Anqing (Anhui Province) | 1999 | 15000-30000 (Mean), 4000 (Median) | 1999 USD |
| Hammitt J. and Zhou Y. (2006) [8] | Beijing | 1999 | 45000-60000 (Mean), 16000 (Median) | 1999 USD |
| Zhang X. (2002) [16] | Beijing | 1999 | 240000-330000 (Mean) | 1999 RMB |
| Deng X. (2006) [17] | Beijing | 2000 | 105000 | 2000 USD |
| Kan H. and Chen B. (2004) [18] | Shanghai | 2001 | 108500(Mean) | 2001 USD |
| Cropper M. (2009) [10] | Shanghai/Jiujiang (Jiangxi Province)/<br>Nanning (Guangxi Province) | 2003 | 1500000 | 2003 RMB |
| Hammitt J., et al. (2019) [11] | Chengdu | 2005 | 154000 | 2005 RMB |
| Guo X., et al.(2006) [19] | China | 2005 | 23745 (Median) | 2005 USD |
| Krupnick A. and Ping Q. (2010) [20] | Shanghai/Jiujiang (Jiangxi Province)/<br>Nanning (Guangxi Province) | 2006 | 2115057 | 2010 RMB |
| Chen Y. (2008) [21] | Shanghai | 2006 | 1482000 (Mean) | 2006 RMB |
| Zeng X. and Jiang Y. (2010) [22] | Shanghai/Jiujiang (Jiangxi Province)/<br>Nanning (Guangxi Province) | 2009 | 1000000 (Median) | 2009 RMB |
| Xie X. (2010) [23] | Beijing | 2010 | 248172 | 2010 USD |
| Gao T., et al. (2015) [24] | Beijing | 2011 | 666667-1333333 | 2011 RMB |
| Hammitt J., et al. (2019) [11] | Chengdu | 2016 | 3850000 | 2016 RMB |
| Cao C, et al. (2021) [9] | Beijing | 2019 | 3810000 | 2019 RMB |

| | | | | |
|---|---|---|---|---|
| Cao C, et al. (2021) [9] | Jinzhong (Shanxi Province) | 2019 | 6360000 | 2019 RMB |
| Cao C, et al. (2021) [9] | Yangzhou (Jiangsu Province) | 2019 | 4920000 | 2019 RMB |
| Cao C, et al. (2021) [9] | Ganzhou (Jiangxi Province) | 2019 | 6350000 | 2019 RMB |
| Cao C, et al. (2021) [9] | Shantou (Guangdong Province) | 2019 | 5370000 | 2019 RMB |
| Cao C, et al. (2021) [9] | Siping (Jilin Province) | 2019 | 3790000 | 2019 RMB |
| Cao C, et al. (2021) [9] | China | 2019 | 5100000 | 2019 RMB |

**Table S4. Data of VSL**

Table S4. Data of VSL (2017 RMB)

| Income elasticity / VSL | 0.8 | 1 | 1.2 | 1.4 | 1.6 |
|---|---|---|---|---|---|
| Min | 117331 | 162359 | 224668 | 310890 | 430202 |
| Max | 5783052 | 5647186 | 6944089 | 8964704 | 11573284 |
| Average | 2526004 | 2945811 | 3499399 | 4233482 | 5212342 |

**Table S5. Reliability analysis minimum value of VSL**

Table S5. Reliability analysis minimum value of VSL (of data from Cao C, et al. 2021)

| Year | Current value of Expected income | VSL in different income elasticity | | | | |
|---|---|---|---|---|---|---|
| | | 0.8 | 1 | 1.2 | 1.4 | 1.6 |
| 2017 | 973627 | 3446190 | 3365226 | 3286164 | 3208959 | 3133569 |
| 2015 | 789192 | 3101016 | 2949309 | 2805023 | 2667796 | 2537283 |
| 2012 | 651416 | 2604130 | 2370929 | 2158611 | 1965307 | 1789312 |
| 2010 | 592826 | 2206135 | 1926994 | 1683172 | 1470201 | 1284177 |
| 2007 | 509043 | 1740597 | 1432891 | 1179581 | 971052 | 799388 |
| 2005 | 424554 | 1442462 | 1132976 | 889891 | 698962 | 548997 |
| 1995 | 188153 | 739985 | 491891 | 326975 | 217350 | 144480 |

**Table S6. Reliability analysis maximum value of VSL**

Table S6. Reliability analysis maximum value of VSL (of data from Cao C, et al. 2021)

| Year | Current value of Expected income | VSL in different income elasticity | | | | |
|---|---|---|---|---|---|---|
| | | 0.8 | 1 | 1.2 | 1.4 | 1.6 |
| 2017 | 973627 | 5783052 | 5647186 | 5514512 | 5384955 | 5258442 |
| 2015 | 789192 | 5203816 | 4949236 | 4707110 | 4476829 | 4257815 |
| 2012 | 651416 | 4369992 | 3978657 | 3622366 | 3297982 | 3002646 |
| 2010 | 592826 | 3702116 | 3233689 | 2824532 | 2467145 | 2154978 |
| 2007 | 509043 | 2920897 | 2404534 | 1979455 | 1629523 | 1341452 |
| 2005 | 424554 | 2420596 | 1901247 | 1493327 | 1172928 | 921271 |
| 1995 | 188153 | 1241769 | 825442 | 548697 | 364736 | 242451 |

**Table S7. Social welfare allocation and health damage data for Figure 2**

Table S7. The provincial ranking based on social welfare allocation and health damage per capita for Figure 2[a]

| **Social income** (1000 CNY/person) | | **Employment rate of participating in national value chain** (person/person) | | **Health economic cost (triggered)** (1000 CNY/person) | | **Health economic cost (suffered)** (1000 CNY/person) | |
|---|---|---|---|---|---|---|---|
| QH | 4.9 | HB | 0.05 | XZ | 0.00 | XZ | 0.00 |
| YN | 5.2 | QH | 0.07 | YN | 0.13 | YN | 0.19 |
| HB | 6.3 | SC | 0.07 | QH | 0.13 | QH | 0.20 |
| GS | 7.5 | SD | 0.08 | HI | 0.20 | XJ | 0.21 |
| NX | 7.6 | NX | 0.09 | FJ | 0.20 | FJ | 0.32 |
| SC | 7.8 | YN | 0.09 | SC | 0.21 | HI | 0.33 |
| XZ | 7.9 | HN | 0.10 | GD | 0.22 | GD | 0.40 |
| SD | 8.4 | XZ | 0.10 | HB | 0.24 | GZ | 0.41 |
| HN | 10.4 | XJ | 0.11 | GX | 0.25 | GS | 0.43 |
| GX | 10.5 | SX | 0.11 | BJ | 0.32 | NX | 0.43 |
| XJ | 11.7 | FJ | 0.13 | XJ | 0.37 | SC | 0.44 |
| SX | 13.1 | TJ | 0.13 | HN | 0.38 | SH | 0.45 |
| GZ | 13.5 | GS | 0.14 | GZ | 0.44 | GX | 0.46 |
| JX | 13.7 | GX | 0.15 | ZJ | 0.44 | ZJ | 0.47 |
| HE | 13.9 | HL | 0.15 | GS | 0.44 | HN | 0.50 |
| FJ | 14.4 | HE | 0.16 | SD | 0.51 | HB | 0.53 |
| AH | 14.8 | GD | 0.16 | HL | 0.52 | CQ | 0.54 |
| GD | 14.9 | HA | 0.17 | SH | 0.52 | SD | 0.57 |
| HA | 16.2 | AH | 0.18 | LN | 0.53 | NM | 0.59 |
| HL | 17.0 | JX | 0.18 | JS | 0.57 | JX | 0.60 |
| LN | 17.9 | GZ | 0.19 | TJ | 0.58 | LN | 0.60 |
| HI | 19.8 | LN | 0.19 | JX | 0.59 | TJ | 0.62 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| JS | 22.1 | NM | 0.22 | JL | 0.67 | BJ | 0.63 |
| ZJ | 22.6 | JS | 0.22 | CQ | 0.73 | JS | 0.64 |
| JL | 22.8 | HI | 0.24 | SX | 0.79 | HL | 0.65 |
| SN | 23.3 | SN | 0.25 | NX | 0.87 | AH | 0.66 |
| CQ | 24.1 | ZJ | 0.27 | SN | 0.89 | JL | 0.68 |
| NM | 24.4 | JL | 0.28 | AH | 0.94 | SX | 0.69 |
| TJ | 36.5 | CQ | 0.29 | HE | 1.07 | SN | 0.72 |
| BJ | 46.5 | BJ | 0.35 | HA | 1.16 | HE | 0.79 |
| SH | 51.0 | SH | 0.41 | NM | 1.29 | HA | 0.84 |

[a] It's sort by ascending order. The above lists are corresponding to Figure 2a-d. the provincial name and abbreviations can be found in Figure 1.

**Table S8. Comparison in the results of health damage assessment based on HEM**

Table S8. Comparison in the results of health damage assessment[a]

| | **Replacement effect and international export change** | | | **Replacement effect** | | |
|---|---|---|---|---|---|---|
| | **Mortality** | **Morbidity** | **Health economic loss** | **Mortality** | **Morbidity** | **Health economic loss** |
| BJ | -8% | -8% | -8% | 5% | 5% | 5% |
| TJ | -11% | -11% | -11% | 6% | 6% | 6% |
| HEB | -13% | -11% | -13% | 9% | 8% | 9% |
| SX | -13% | -12% | -13% | 7% | 6% | 7% |
| NM | -11% | -9% | -11% | 6% | 4% | 6% |
| LN | -8% | -7% | -8% | 5% | 5% | 5% |
| JL | -13% | -11% | -13% | 1% | 1% | 1% |
| HL | 7% | 6% | 7% | 23% | 17% | 23% |
| SH | -12% | -12% | -12% | 8% | 7% | 8% |
| JS | -5% | -5% | -5% | 14% | 13% | 14% |
| ZJ | -7% | -7% | -7% | 8% | 7% | 8% |
| AH | -5% | -5% | -5% | 10% | 9% | 10% |
| FJ | -7% | -7% | -7% | 7% | 6% | 7% |
| JX | -12% | -11% | -12% | 6% | 6% | 6% |
| SD | -9% | -9% | -9% | 11% | 10% | 11% |
| HEN | -11% | -9% | -11% | 8% | 7% | 8% |
| HUB | -8% | -9% | -8% | 9% | 8% | 9% |
| HUN | -7% | -7% | -7% | 7% | 6% | 7% |
| GD | -1% | -2% | -1% | 13% | 11% | 13% |
| GX | -8% | -8% | -8% | 9% | 8% | 9% |
| HAN | -13% | -4% | -13% | 2% | 1% | 2% |
| CQ | -10% | -9% | -10% | 3% | 2% | 3% |
| SC | -3% | -3% | -3% | 6% | 5% | 6% |
| GZ | -14% | -13% | -14% | 2% | 2% | 2% |
| YN | -13% | -7% | -13% | 4% | 7% | 4% |
| XZ | -11% | 0% | -11% | 0% | 0% | 0% |
| SNX | -10% | -8% | -10% | 6% | 4% | 6% |
| GS | -9% | -1% | -9% | 4% | 6% | 4% |
| QH | -16% | 0% | -16% | 1% | 0% | 1% |
| NX | -19% | -11% | -19% | 1% | 0% | 1% |
| XJ | -15% | 0% | -15% | 0% | 0% | 0% |

[a] The figures are calculated by: (original results-HEM results)/HEM results

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## Code

### Code for value chain decomposition

```
#this code is for value chain decomposition based on R language

sector = 42
region = 31
final.demand = 5

#inputmrio
options(digits = 22)
mrio <- read.delim("210520-MRIO17.txt", header=FALSE)
mrio<-as.matrix(mrio)


df.T<-mrio[1:(sector*region),1:(sector*region)]
FD<-mrio[1:(sector*region),(sector*region+1):(sector*region+region*final.demand)]
df.EX<-mrio[1:(sector*region),(sector*region+region*final.demand+1)]
df.Other<-mrio[1:(sector*region),(sector*region+region*final.demand+2)]
df.IM<-mrio[(region*sector+1),]


df.T[(df.T<0.0001)&(df.T>-0.0001)]<-0
FD[(FD<0.0001)&(FD>-0.0001)]<-0
df.EX[(df.EX<0.0001)&(df.EX>-0.0001)]<-0
df.Other[(df.Other<0.0001)&(df.Other>-0.0001)]<-0
df.IM[(df.IM<0.0001)&(df.IM>-0.0001)]<-0

df.TO<-rowSums(df.T)+rowSums(as.matrix(FD))+df.EX+df.Other



#input satellite data
setwd("D:/B/GVC/H/20230610HEM/ori calculate 17 SI-EM-AP/data")
Qa<-read.csv("AIR SI EM-2017-42-ceads-210520.csv",sep=',',head=FALSE)

# 1 so2; 2 nox; 3 pm2.5; 4 voc; 5 nh3; 6.social income; 7.employment
for(select_AP in 1:7){

  labelAP<-c("so2","nox","pm2.5","nmvoc","nh3","si","em")
  print(labelAP[select_AP])

  Qa_select<-Qa[,((select_AP-1)*region+1):(select_AP*region)]
  df.Qa<-as.vector(t(t(Qa_select)))
```

```
  df.Q<-as.vector(df.Qa)


  selFD<-array(0,dim=c((sector*region),region,(final.demand+2)))
  for(i in 1:final.demand){
    for(j in 1:region){
      selFD[,j,i]<-FD[,((j-1)*final.demand+i)]
      selFD[,j,(final.demand+1)]<-apply(FD[,((j-
1)*final.demand+1):(j*final.demand)],1,sum)
      selFD[,j,(final.demand+2)]<-apply(FD[,((j-1)*final.demand+1):(j*final.demand-
1)],1,sum)
    }
  }

  df.FD<-selFD[,,(final.demand+1)]############## do not consider different final
demand categories (just analysis the gross)
  df.FD<-as.matrix(df.FD)


  df.T <- as.matrix(df.T)
  df.Q<-as.matrix(t(df.Q))
  df.EX<-as.matrix(df.EX)

  total.output <- rowSums(df.T)+rowSums(as.matrix(selFD[,,(final.demand+1)]))+df.EX


  #calculate intensity and A

  intensity <- 1:(sector*region)
  intensity[] <- 0
  for(i in 1:(sector*region)){
    if(total.output[i] > 0.0000001){
      intensity[i] <- df.Q[i]/total.output[i]
    }
    else
      intensity[i] <- 0
  }
  intensity <-as.matrix(t(intensity))

  A <- matrix(0,nrow = (sector*region),ncol = (sector*region))
  for(i in 1:(sector*region)){
    for(j in 1:(sector*region)){
      if(total.output[j] > 0.0000001){
        A[i,j] <- df.T[i,j]/total.output[j]
      }
      else
```

```
      A[i,j] <- 0
    }
  }


  #original: no HEM
  A0<-A
  df.FD0<-df.FD
  B0 <- solve(diag(1, nrow(A0)) - A0);



  #functions----------------------------------
  sd<-1#select one as domestic(sample.d)
  sb<-2#select the other in a bilateral relationship with sample.d(sample.b)


  F.F<-function(sd){
    return(intensity[((sd-1)*sector+1):(sd*sector)])
  }

  F.A<-function(sd,sb){
    return(A0[((sd-1)*sector+1):(sd*sector),((sb-1)*sector+1):(sb*sector)])
  }

  F.B<-function(sd,sb){
    return(B0[((sd-1)*sector+1):(sd*sector),((sb-1)*sector+1):(sb*sector)])
  }


  F.YY<-function(sd,sb){
    return(df.FD0[((sd-1)*sector+1):(sd*sector),sb])
  }

  F.EX<-function(sd){###international export
    return(df.EX[((sd-1)*sector+1):(sd*sector),1])
  }

  F.L <- function(sd){
    l<-solve(diag(1, sector) - A0[((sd-1)*sector+1):(sd*sector),((sd-
1)*sector+1):(sd*sector)])
    return(l)
  }

  #functions----END
```

```
#result1: decompose the gross emission of every region.
DDTOTAL<-matrix(0,region,6)

ex.region<-matrix(0,region,region)
B0<-as.matrix(B0)
df.EX<-as.vector(df.EX)
for(i in 1:region){
  for(j in 1:region){
    ex.region[i,j]<- intensity[((i-1)*sector+1):(i*sector)]%*%B0[((i-
1)*sector+1):(i*sector),((j-1)*sector+1):(j*sector)]%*%df.EX[((j-
1)*sector+1):(j*sector)]
  }
}
DDTOTAL[,1]<-apply(ex.region,1,sum)

#part.1  FssLssYss, corresponding to equation(3) first term in manuscript
DD1<-matrix(0,region,1)
for(sd in 1:region){
  c1<-c(1:region)    ###whole 31 provinces
  d<-which(c1==sd)
  c2<-c1[-d]    ###31 provinces without selected domestic one
  DD1[sd,1]<-F.F(sd)%*%F.L(sd)%*%F.YY(sd,sd)
}
DDTOTAL[,2]<-DD1

#part.2  export and then import to return, corresponding to equation(3) second term in
manuscript
DD2<-matrix(0,region,1)
for(sd in 1:region){
  c1<-c(1:region)    ###whole 31 provinces
  d<-which(c1==sd)
  c2<-c1[-d]
  part2<-0
  for(i in c2){
    for(j in c1){
      part2<-part2+F.F(sd)%*%F.L(sd)%*%F.A(sd,i)%*%F.B(i,j)%*%F.YY(j,sd)
    }
  }
  DD2[sd,1]<-part2
}
DDTOTAL[,3]<-DD2


#part.3  Fs Bss Ysr, corresponding to equation(3) third term in manuscript
DD3<-matrix(0,region,region)
for(sd in 1:region){
```

```
  c1<-c(1:region)    ###whole 31 provinces
  d<-which(c1==sd)
  c2<-c1[-d]
  for(i in c2){
    DD3[sd,i]<-F.F(sd)%*%F.B(sd,sd)%*%F.YY(sd,i)
  }
 }
 DDTOTAL[,4]<-apply(DD3,1,sum)

 #part.4  Fs Bsr Yrr, part4+part5 corresponding to equation(3) fourth term in
manuscript
 DD4<-matrix(0,region,region)
 for(sd in 1:region){
  c1<-c(1:region)    ###whole 31 provinces
  d<-which(c1==sd)
  c2<-c1[-d]
  for(i in c2){
    DD4[sd,i]<-F.F(sd)%*%F.B(sd,i)%*%F.YY(i,i)
  }
 }
 DDTOTAL[,5]<-apply(DD4,1,sum)


 #part.5  Fs Bst Ytr, part4+part5 corresponding to equation(3) fourth term in manuscript
 DD5<-matrix(0,region,region)
 for(sd in 1:region){
  c1<-c(1:region)    ###whole 31 provinces
  d<-which(c1==sd)
  c2<-c1[-d]
  for(i in c2){
    d1<-which(c2==i)
    c3<-c2[-d1]
    part5<-0
    for(t in c3){
      part5<-part5+F.F(sd)%*%F.B(sd,t)%*%F.YY(t,i)
    }
    DD5[sd,i]<-part5
  }
 }
 DDTOTAL[,6]<-apply(DD5,1,sum)

 write.csv(DDTOTAL,paste0("DDTOTAL-",labelAP[select_AP],"-2017.csv"))

 #result2: local and upstream sectoal decomposition, corresponding to equation(4,5) in
manuscript
 EEXs<-array(0,dim=c((region*sector),(region*3+2)))
```

```
EEX<-array(0,dim=c(region,(region*3+2)))

c1<-c(1:region)   ###c1 includes all the countries
for(sd in c1){
  d1<-which(c1==sd)
  c2<-c1[-d1]   ###c2 includes all the countries except local (sd), and then select partner
  for(sb in c2){
    d2<-which(c2==sb)
    c3<-c2[-d2]   ###c3 includes all the countries except local (sd) and its trade partner (sb), and then select the third

    EEX1<-sweep(t(F.F(sd)%*%F.B(sd,sd)),1,F.YY(sd,sb),"*")#EEX1, corresponding to equation(4) first term
    EEX2<-sweep(t(F.F(sd)%*%F.L(sd)),1,(F.A(sd,sb)%*%F.B(sb,sb)%*%F.YY(sb,sb)),"*")#EEX2, EEX2+EEX3 corresponding to equation(4) second term

    a<-0
    b<-0
    c<-0
    for(i in c3){
      d3<-which(c2==i)
      c4<-c2[-d3]  ###c4 includes all the countries except local (sd) and the selected third country (i)
      a<-a+F.A(sd,sb)%*%F.B(sb,sb)%*%F.YY(sb,i)
      b<-b+F.A(sd,sb)%*%F.B(sb,i)%*%F.YY(i,i)
      for(j in c4){
        c<-c+F.A(sd,sb)%*%F.B(sb,i)%*%F.YY(i,j)
      }
    }

    EEX3<-sweep(t(F.F(sd)%*%F.L(sd)),1,(a+b+c),"*")#EEX3, EEX2+EEX3 corresponding to equation(4) second term

    EEX[sd,sb]<-sum(EEX1)
    EEX[sd,(sb+region+1)]<-sum(EEX2)
    EEX[sd,(sb+2*region+2)]<-sum(EEX3)
    EEXs[((sd-1)*sector+1):(sd*sector),sb]<-EEX1
    EEXs[((sd-1)*sector+1):(sd*sector),(sb+region+1)]<-EEX2
    EEXs[((sd-1)*sector+1):(sd*sector),(sb+2*region+2)]<-EEX3
  }
}


write.csv(EEX,paste0("EEX-",labelAP[select_AP],".CSV"))
```

```
write.csv(EEXs,paste0("EEXs-",labelAP[select_AP],".CSV"))


FEEs<-array(0,dim=c((region*sector),(region*4+3)))
FEE<-array(0,dim=c(region,(region*4+3)))

c1<-c(1:region)
for(sd in c1){
  print(sd)
  d1<-which(c1==sd)
  c2<-c1[-d1]
  for(sb in c2){
    d2<-which(c2==sb)
    c3<-c2[-d2]

    FEE1<-sweep(t(F.F(sb)%*%F.B(sb,sd)),1,F.YY(sd,sb),"*")
    FEE2<-
sweep(t(F.F(sb)%*%F.B(sb,sd)),1,(F.A(sd,sb)%*%F.L(sb)%*%F.YY(sb,sb)),"*")

    a<-0
    b<-0
    for(i in c3){
      a<-a+sweep(t(F.F(i)%*%F.B(i,sd)),1,F.YY(sd,sb),"*")
      b<-
b+sweep(t(F.F(i)%*%F.B(i,sd)),1,(F.A(sd,sb)%*%F.L(sb)%*%F.YY(sb,sb)),"*")
    }
    FEE3<-a
    FEE4<-b

    #FEE1+FEE3: corresponding to equation(5) first term
    #FEE2+FEE4: corresponding to equation(5) second term

    FEE[sd,sb]<-sum(FEE1)
    FEE[sd,(sb+region+1)]<-sum(FEE2)
    FEE[sd,(sb+2*region+2)]<-sum(FEE3)
    FEE[sd,(sb+3*region+3)]<-sum(FEE4)
    FEEs[((sd-1)*sector+1):(sd*sector),sb]<-FEE1
    FEEs[((sd-1)*sector+1):(sd*sector),(sb+region+1)]<-FEE2
    FEEs[((sd-1)*sector+1):(sd*sector),(sb+2*region+2)]<-FEE3
    FEEs[((sd-1)*sector+1):(sd*sector),(sb+3*region+3)]<-FEE4
  }
}

write.csv(FEE,paste0("FEE-",labelAP[select_AP],".CSV"))
write.csv(FEEs,paste0("FEEs-",labelAP[select_AP],".CSV"))
```

}

**Code for HEM**

#The code for HEM adds a process of A matrix and FD vectors based on Code for value chain decomposition. Here only present the code of processing.

```
  #select local production network
  HEM_outputmerge1<-matrix(0,region,region)#sum up 1-6(so as to see the total change)
  HEM_outputmerge2<-matrix(0,region,region)#sum up 2-6(so as to see the domestic change)(include local)
  HEM_outputmerge3<-matrix(0,region,region)#sum up 3-6(so as to see the intra-regional change)

  # HEM (remove inter-regional outflows of every region)

  for (exone in 1:p){
    print(paste0("remove province: ",exone))


    #build new A------
    HEM_A0<-A
    #select exone's local production network
    Aang<-matrix(0,nrow = (sector*region),ncol = (sector*region))
    Aang[((exone-1)*s+1):(exone*s),((exone-1)*s+1):(exone*s)]<-A[((exone-1)*s+1):(exone*s),((exone-1)*s+1):(exone*s)]

    #eliminate outflows of exone region
    HEM_A0[((exone-1)*s+1):(exone*s),]<-0

    #merge the above two: remian the local but remove the inter-regional outflows of exone
    HEM_A<-HEM_A0+Aang

    #A gap
    sumA<-matrix(0,nrow = (sector),ncol = (sector*region))
    sumA_HEM<-matrix(0,nrow = (sector),ncol = (sector*region))
    for(i in 1:s){
      for(j in 1:p){
        sumA[i,]<-sumA[i,]+A[((j-1)*sector+i),]
        sumA_HEM[i,]<-sumA_HEM[i,]+HEM_A[((j-1)*sector+i),]
      }
    }
    sumA_gap<-matrix(0,nrow = (sector),ncol = (sector*region))
    sumA_gap<-sumA-sumA_HEM
```

```
#A shares for the rest
A_share<-matrix(0,nrow = (sector*region),ncol = (sector*region))
for(j in 1:p){
  iv_sumA_HEM<-sumA_HEM^(-1)
  iv_sumA_HEM[iv_sumA_HEM==Inf]<-0
  A_share[((j-1)*s+1):(j*s),]<-HEM_A[((j-1)*s+1):(j*s),]*iv_sumA_HEM
}

A_share[is.na(A_share)]<-0
#colSums(A_share)

HEM_A_needreplace<-matrix(0,nrow = (sector*region),ncol = (sector*region))
for(j in 1:p){
  HEM_A_needreplace[((j-1)*s+1):(j*s),]<-A_share[((j-1)*s+1):(j*s),]*sumA_gap
}


#HEM_A include replace
HEM2_A<-HEM_A+HEM_A_needreplace

#build new A-------end

#build new FD-------
HEM_FD0<-df.FD
#select exone's local production network
FDang<-matrix(0,nrow = (sector*region),ncol = (region))
FDang[((exone-1)*s+1):(exone*s),exone]<-df.FD[((exone-1)*s+1):(exone*s),exone]

#eliminate export of exone region
HEM_FD0[((exone-1)*s+1):(exone*s),]<-0

#merge the above two: remian the local but remove the inter-regional outflow of exone
HEM_FD<-HEM_FD0+FDang


#y gap
sumy<-matrix(0,nrow = (sector),ncol = (region))
sumy_HEM<-matrix(0,nrow = (sector),ncol = (region))
for(i in 1:s){
  for(j in 1:p){
    sumy[i,]<-sumy[i,]+df.FD[((j-1)*sector+i),]
    sumy_HEM[i,]<-sumy_HEM[i,]+HEM_FD[((j-1)*sector+i),]
  }
}
sumy_gap<-sumy-sumy_HEM
```

```
#y shares for the rest
y_share<-matrix(0,nrow = (sector*region),ncol = (region))
for(j in 1:p){
  iv_sumy_HEM<-sumy_HEM^(-1)
  iv_sumy_HEM[iv_sumy_HEM==Inf]<-0
  y_share[((j-1)*s+1):(j*s),]<-HEM_FD[((j-1)*s+1):(j*s),]*iv_sumy_HEM
}

y_share[is.na(y_share)]<-0
#colSums(y_share)

HEM_y_needreplace<-matrix(0,nrow = (sector*region),ncol = (region))
for(j in 1:p){
  HEM_y_needreplace[((j-1)*s+1):(j*s),]<-y_share[((j-1)*s+1):(j*s),]*sumy_gap
}


#HEM_FD include replace
HEM2_FD<-HEM_FD+HEM_y_needreplace


#build new FD-------end


#ori: no HEM
#A0<-A
#df.FD0<-df.FD

#HEM
A0<-HEM_A
df.FD0<-HEM_FD
```

**Code for health impact assessment**

```
%this code is for health impact assessment based on MATLAB

ICONC1s=[1];
ICONC2s=[0];
[POPs,TXT,RAW]=xlsread('file0.xlsx','pop','B3:B42226');
[AGEs,TXT,RAW]=xlsread('file0.xlsx','CRF','J2:J86');
[CRFs,TXT,RAW]=xlsread('file0.xlsx','CRF','D2:F86');
[INCs,TXT,RAW]=xlsread('file0.xlsx','CRF','I2:I86');
nendpoint = 5;
STageconcs = [1, 10, 37, 48, 56];
EDageconcs = [9, 36, 47, 55, 85];
```

```
%setting formats
result_re = csvread('file1 dataframe.csv',1,0,[1 0 31 1]); % a dataframe for regional results of mortality
illresult_re = csvread('file1 dataframe.csv',1,0,[1 0 31 1]);
illresult_re1 = csvread('file1 dataframe.csv',1,0,[1 0 31 1]);
illresult_re2 = csvread('file1 dataframe.csv',1,0,[1 0 31 1]);
illresult_re3 = csvread('file1 dataframe.csv',1,0,[1 0 31 1]);
illresult_re4 = csvread('file1 dataframe.csv',1,0,[1 0 31 1]);
result_20 = csvread('file1 dataframe.csv',1,0,[1 0 31 1]);
illresult_20 = csvread('file1 dataframe.csv',1,0,[1 0 31 1]);

result_10 = csvread('file2 matching table.csv',1,1,[1 1 42224 2]); % a matching table for grids and regions
illresult_10 = csvread('file2 matching table.csv',1,1,[1 1 42224 2]);


    pppppath = "D:\health";
    path = dir(pppppath);

    ncase = length(path)-2;
    cont = 2
    nrow = 42224 % number of grids
    AC_total = zeros(nrow,ncase);
    AC_illtotal = zeros(nrow,ncase);
    AC_illtotal1 = zeros(nrow,ncase);
    AC_illtotal2 = zeros(nrow,ncase);
    AC_illtotal3 = zeros(nrow,ncase);
    AC_illtotal4 = zeros(nrow,ncase);

    % Progress bar
    h=waitbar(0,'Data export in progress……');
    pause(1);

    for icase = 1:1:(ncase)

        p=fix(icase/ncase*10000)/100;

   str=[' The output is in progress and the current progress is ',num2str(p),' %，  finished! ',num2str(icase),'/',num2str(ncase)];

   waitbar(icase/ncase,h,str);

   %------------------------

    result_1 = result_10;
    result_2 = result_20;
```

```
    illresult_1 = illresult_10;
    illresult_11 = illresult_10;
    illresult_12 = illresult_10;
    illresult_13 = illresult_10;
    illresult_14 = illresult_10;
    illresult_2 = illresult_20;
    illresult_21 = illresult_20;
    illresult_22 = illresult_20;
    illresult_23 = illresult_20;
    illresult_24 = illresult_20;


    nameicase=num2str(icase);
    fileposition = strcat(pppppath,"\",nameicase,"201701.csv");
    CONCs = csvread(fileposition,2,11,[2 11 42225 11]); % Scenario Data Import
    tmp = size(CONCs);
    nrow = tmp(1);

    conc2 = zeros(nrow,1);
    conc1 = CONCs(:,1);
    pop = POPs(:,1);%unit: 10000 person
    age = AGEs(:,1);
    inc = INCs(:,1);

    %health end is death
    AC_endpoint = zeros(nrow,nendpoint);
    for iendpoint = 1:nendpoint
       AC_ageconc = zeros(nrow,EDageconcs(iendpoint)-STageconcs(iendpoint)+1);
       for iageconc = STageconcs(iendpoint):EDageconcs(iendpoint)
          deltaconc=(min(conc1,CRFs(iageconc,2))-
max(conc2,CRFs(iageconc,1))).*(conc1>conc2).*(conc1>CRFs(iageconc,1)).*(conc2<=
CRFs(iageconc,2))...
                 +(min(conc2,CRFs(iageconc,2))-
max(conc1,CRFs(iageconc,1))).*(conc1<=conc2).*(conc2>CRFs(iageconc,1)).*(conc1<
=CRFs(iageconc,2));
          rr=(1-(1./exp(CRFs(iageconc,3)*deltaconc))).*((conc1>conc2)-(conc1<=conc2));
          AC_ageconc(:,iageconc-
STageconcs(iendpoint)+1)=rr.*pop*age(iageconc,1)*inc(iageconc,1)/100/100000*10000
;
       end
       AC_endpoint(:,iendpoint)=sum(AC_ageconc,2);
    end
    AC_total(:,(icase))=sum(AC_endpoint,2);
    result_1(:,1) = sum(AC_endpoint,2);%input to match file
```

```
%health end is illness
AC_ill = zeros(nrow,4);
E0 = [0.00694,0.00546,0.0094,0.038];% Baseline incidence
beta = [0.0027,0.00068,0.0021,0.0079];% Exposure-response coefficient mean value
C0 = 10; % PM2.5 concentration; here can set as 5, 10, 15 μg m-3

for ill = 1:4
   Ei = E0(ill).*exp(beta(ill).*(conc1-C0)).*(conc1>C0);
   HIi = pop.*(Ei-E0(ill)).*(Ei>E0(ill)).*10000;
   AC_ill(:,ill) = HIi;
end
AC_illtotal(:,(icase))=sum(AC_ill,2);
AC_illtotal1(:,(icase)) = AC_ill(:,1);
AC_illtotal2(:,(icase)) = AC_ill(:,2);
AC_illtotal3(:,(icase)) = AC_ill(:,3);
AC_illtotal4(:,(icase)) = AC_ill(:,4);

illresult_1(:,1) = sum(AC_ill,2);%input to match file
illresult_11(:,1) = AC_ill(:,1);
illresult_12(:,1) = AC_ill(:,2);
illresult_13(:,1) = AC_ill(:,3);
illresult_14(:,1) = AC_ill(:,4);

%combine to 31 provinces
for re = 1:42224
   if result_1(re,2) ~= 0
      for re2 = 1:31
         if result_1(re,2) == result_2(re2,1)
            result_2(re2,2) = result_2(re2,2)+result_1(re,1) ;
            illresult_2(re2,2) = illresult_2(re2,2)+illresult_1(re,1) ;
            illresult_21(re2,2) = illresult_21(re2,2)+illresult_11(re,1) ;
            illresult_22(re2,2) = illresult_22(re2,2)+illresult_12(re,1) ;
            illresult_23(re2,2) = illresult_23(re2,2)+illresult_13(re,1) ;
            illresult_24(re2,2) = illresult_24(re2,2)+illresult_14(re,1) ;
         end
      end
   end
end

result_re(1:31,cont) = result_2(1:31,2);
illresult_re(1:31,cont) = illresult_2(1:31,2);
illresult_re1(1:31,cont) = illresult_21(1:31,2);
illresult_re2(1:31,cont) = illresult_22(1:31,2);
illresult_re3(1:31,cont) = illresult_23(1:31,2);
illresult_re4(1:31,cont) = illresult_24(1:31,2);
```

```
    result_re(32,cont) = strcat(nameicase,"201701");
    illresult_re(32,cont) = strcat(nameicase,"201701");
    illresult_re1(32,cont) = strcat(nameicase,"201701");
    illresult_re2(32,cont) = strcat(nameicase,"201701");
    illresult_re3(32,cont) = strcat(nameicase,"201701");
    illresult_re4(32,cont) = strcat(nameicase,"201701");
    cont = cont+1;

    %------------------------

    end

close(h);
msgbox('finished~');


illresult_resep = zeros((32*4),(ncase*4));
illresult_resep(1:32,1:(ncase+1)) = illresult_re1;
illresult_resep(33:64,(ncase+2):(2*ncase+2)) = illresult_re2;
illresult_resep(65:96,(2*ncase+3):(3*ncase+3)) = illresult_re3;
illresult_resep(97:128,(3*ncase+4):(4*ncase+4)) = illresult_re4;

format long

dlmwrite(strcat(pppppath,"\","deathresult_nocombine.csv"),AC_total,'precision','%.6f');
dlmwrite(strcat(pppppath,"\","deathresult_combine.csv"),result_re,'precision','%.9f');
dlmwrite(strcat(pppppath,"\","total_illresult_nocombine.csv"),AC_illtotal,'precision','%.6
f');
dlmwrite(strcat(pppppath,"\","total_illresult_combine.csv"),illresult_re,'precision','%.9f');
dlmwrite(strcat(pppppath,"\","sep4_illresult_combine.csv"),illresult_resep,'precision','%.
9f');

save AC_total;
save result_re;
save AC_illtotal;
save illresult_re;
save illresult_resep;
```