Responses to Comments from R1

1. One methodological issue is the translation of mortality into working days lost. In section 4.4, this is described as "each death will result in a total 250 working days lost . . .". It confuses me why one death only results in one-year working days lost instead of years he supposes to work till retirement. We often consider the PM2.5-induced health impacts in a cumulative way, and that's what the disability-adjusted life year (DALY) stand for. DALYs represent the lost years of "healthy" life. DALYs for one premature death is determined as the standard life expectancy at age of death in years. If one death only accounted for one lost year of healthy life, then DALY would be significantly underestimated. It's rather the same to calculate lost years for working. One may argue that working days lost in years after 2012 don't account for the economic loss in 2012. Then mortality occurring before 2012 should be taken into account to comprehend the 2012 economic loss. Otherwise, the economic loss would be underestimated. The authors should clarify this.

Thank you for your constructive comments. We fully agree that air pollution-induced mortality and morbidity will result in long-lasting impacts that will definitely far exceed a single labour year loss or certain amount of working time loss. However, the focus of the paper and the proposed multi regional input-output (MRIO) model is the resulting health outcome and its impacts on labour time among all Chinese labourers during a single year of 2012. We acknowledge that compared with our proposed MRIO model, DALYs approach tends to provide more information on economic loss from the standpoint of each individual patient. However, we suggest that methods like DALYs and willingness-to-pay approach are likely to lose their sights on macroeconomic impacts which consider interdependencies among industries.

We fully agree that we need to better clarify these points and have done this by adding '*However, when perceiving unhealthy laborers as degradation in labor input, macroeconomic implications for production supply chains lack investigation. While traditional approaches for health costs estimates are able to provide more information on economic loss from a standpoint of individual patients, we suggest that they are likely to lose sights on the cascading effects due to labour time loss across interrelating industries.*' and '*In other words, it aims to investigate the overall economic loss resulting from health-induced labour time reduction among all Chinese labourers for a year of 2012.'* in the introduction section.

2. To cascade the impacts of working days lost into production supply chain, the percentage reductions in labor time loss were directly used as the percentage reductions in industrial value added in the IO model. This should be based on the presumption that labor inputs dominate the industrial values added, which might not be the case in certain capital-intensive industry. The authors may need to clarify to what extent labor inputs contribute to industrial values added in different sectors, and if not dominant, how this assumption will bias their results.

Thank you for your insightful comments. We fully agree that in reality, industries express different levels of dependencies on labour and capital. However, we used percentage reductions in labour time as a direct indicator for reductions in industrial value added because it is a fundamental assumption of production expansion path underlying input-output model. The model assumes that the same proportional increase in output can be only achieved by simultaneous increases in both capital and labour input. In other words, reduction in an input can directly constrain the growth in output.

We have clarified this assumption in Method section Industrial Labour Time Loss subsection as '*We need to clarify that the industries can express very different levels of dependencies on capital and labour in reality. However, percentage reductions in labour time were used as a direct indicator for percentage reduction in industrial value added due to the assumption of production expansion path underlying input-output model. An input-output model assumes that proportional increase in industrial output can be only achieved by simultaneous increases in both capital and labour, indicating that any reduction in an input can directly constrain the output growth in all industries*.'

Specific comments:
1. The Methods section should go before the Results section.

Thank you. We have made the change accordingly.

2. How was the direct economic loss calculated?

Thank you for the question.

For a demand-driven input-output model, the direct effects on the economy with respect to households are measured by the initial dollar value change of sector j's output that resulted from a change in dollar value of final demand. Thus, direct economic losses estimate the initial reductions in the dollar value of sector j's output caused by the decrease in its final demand. In addition, because:

$x = Lf$ and $\Delta x = L\Delta f$

$L = (I-A)^{-1} = I+A+A^2+A^3+...$

the direct effects are associated with **I** and measured by the initial output change in sector j caused by the change in final demand of this sector.

At the same time, we refer to the accumulated effects caused by industrial inter-dependencies as indirect effects. They measure the reductions in dollar value among the outputs of other sectors caused by the reduced output of sector j, which is caused by a decrease in its final demand. The indirect effects are related to **$A+A^2+A^3+\ldots$**

While a demand-driven input-output model suggests that production affects sectors that provide its primary inputs, our proposed supply-driven input-output model emphasises that production could also affect sectors that purchase its outputs as inputs in their production processes. It takes the form as:
$x' = v' (I-B)^{-1}$

when **$G = (I-B)^{-1}$**, equation becomes:

$x' = v' G$ (resulting gross output in a row view) or
$x = G' v$ (resulting gross output in a column view)

G and **G'** are the output/Ghosh inverse and the element g_{ij} indicates the value of each unit of primary inputs in sector i that enters sector j. The supply-side approach assumes a fixed output distribution. Therefore, with fixed output coefficient b_{ij}, we can trace changes in sectoral gross outputs caused by changes in the amount of primary inputs using **$\Delta x = \Delta v' G$**. The supply-driven I-O model measures the direct economic losses as the initial dollar value decrease of sector j's outputs that resulted from a decrease in the dollar value of value added and are related to **I**, whereas the indirect economic losses refer to the accumulated reductions in dollar value among other sectors' outputs caused by the reduced outputs of sector j, which is caused by a decrease in its value added and are associated with **$B+B^2+B^3+\ldots$**.

3. The Introduction only contains one citation. A plenty of sentences need references. For example, "Serious air pollution in China has largely inspired epidemic studies that examine ..."; "Existing epidemic studies simulate a exposure-response relationships between Particulate Matter (PM) concentration

levels and relative risks (RRs) for a particular disease"; "while health costs assessments frequently stem from patients' perspective at microeconomic level. . ."; "Inspired by our previous work. . .", and etc.

Thank you for your comments. We have added in references in both text and reference list to support our arguments. We have also arranged reference list in alphabetic order.

4. Line 85, "Guangdong province. . ., where a substantial increase can be observed at 175 thousands compared with results in 2007". Why did it increase? Additionally, "175 thousands" should be "175 thousand".

Thank you for your comments. We have changed 'thousands' into 'thousand'.

The reason behind the substantial rise in hospital admissions from its 2007 level is mainly because of a larger exposed population (from 94.49 million in 2007 to 105.94 million in 2012), despite sustained level in pollution concentrations.

5. There're several sentences start with "I" such as sentences in Line 107, 121, 159, and etc, where "we" is expected.

Thank you for your comments. We have changed them into 'We'.

6. Line 112, " Primary industry includes agriculture and fishing suffered the economic loss at 19.12 billion Yuan". The sentence needs to be rewritten.

Thank you for your comments. We have rewritten the sentence as '*Primary industry includes agriculture and fishing entail the economic loss at 19.12 billion Yuan*.'

7. Line 123, "The left-hand side shows the regional indirect economic loss while the right-hand side denotes the sources for these indirect economic loss. The proportion of regional indirect loss among regional total economic loss is displayed next to each region's name on the left-hand side". Some of the information has been mentioned in the figure caption and thus don't need to be mentioned in the main text.

Thank you for your comments. We have removed the repetitive sentences.

8. Line 355, "We referred to an integrated exposure-response (IER) model developed by Burnett et al (2014) . . .". The reference was not found in the reference list. Also, the IER model in Burnett's study cannot be used to estimate hospital admissions and outpatient visits. need more accurate description here.

Thank you for your comments. We have added Burnett et al (2014) into the reference list.

For air pollution-induced morbidity (hospital admissions and outpatient visits), we referenced the method used in Xia et al (2016) and Jiang et al (2015).

Specifically, we evaluated cardiovascular and respiratory hospital admissions and outpatient visits for all causes as the health endpoints of $PM_{2.5}$ air pollution. The log-linear response function was applied to estimate health outcomes, and the relative *RR* for morbidity estimation was calculated by:

$$RR = e^{\beta x}$$

where β is the parameter that describes the depth of the curve (SI-Table SI-1). They are the exposure-response coefficients which are used to quantify the relationship between different levels of $PM_{2.5}$ exposures and the resulting health effects. Then, the calculated RR were further converted into health outcome (hospital admission counts and outpatient visits) using the PAF formula.

9. Line 370, "Then, the calculated RR was then converted into an attributable fraction (AF) in Eq.(2)". Delete the second (or the first) "then".

Thank you for your comments. We have made the change accordingly.

10. Line 385, "ÎŠ: the parameter that describes the depth of the curve (Table SI-1 in Supplementary Information)". There're two Table S1 in Supplementary Information.

Thank you for your comments. We have corrected this in Supplementary Information.