

Authors' reply to referee 1

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The sources of the evolution of China's provincial economic gap: a green economic growth accounting perspective

We are grateful to the referee for reading our work and providing valuable feedback. We believe that all of these comments will help us to improve our paper. Of course, we also thank the referee for his recognition of our previous work.

Below are our replies (in red) to the comments.

Major issues:

1. However, there is a lack of explanation why the authors put energy and environmental factors into the analysis. What is the rationale?

Thank you for your opinion, and it is a good guide for the subsequent improvement of our paper. Although some of the studies we cited have mentioned this, we did not elaborate it in the paper. Of course, we will supplement it in a revised version of this paper.

In the past 20 years, many studies have incorporated energy and environmental factors into the analysis of efficiency and productivity, such as Chung et al. (1997), and please refer to some review literature for details such as Tyteca (1996), Zhou et al. (2008), Ramli and Munisamy (2013). However, they did not introduce energy and environmental factors into growth accounting analysis.

As we all know, many firms not only produce desired outputs (also known as good outputs) such as value added, but also produce by-products (also known as undesired or bad outputs) such as pollutant emissions. In addition, many firms face environmental regulations, so they need to divert or increase some inputs to reduce pollutant emissions, resulting in changes in the quantity of desired and undesired outputs. However, traditional productivity measures such as Solow Residual and Törnqvist index don't take into account environmental factors, which may cause biased productivity measures (Chung et al., 1997).

Now, let's look at the green growth accounting analysis. In the presence of environmental regulations, traditional growth accounting can account for changes in inputs and desired outputs, but it can't handle changes in undesired outputs. In other words, the productivity of firms facing environmental regulations will be adversely affected in the traditional productivity measures, because the cost of abatement capital will be included on the input side, while reduced pollutant emissions will not be included on the output side. Obviously, this kind of productivity analysis that ignores environmental factors will inevitably cause

biased productivity estimates, which will cause incorrect calculations of the relative contributions of factor accumulation and TFP changes to economic growth. In addition, the carbon dioxide and sulfur dioxide emissions of firms mainly come from the use of energy. According to the principle of materials balance, when undesired outputs (pollution emissions in this paper) are introduced into the green growth accounting, the pollution-generating inputs (energy in this paper) should also be included on the input side (Murty et al., 2011). (Murty et al., 2011).

Therefore, we have performed a green growth accounting in this paper, including energy and environmental factors into the analysis, which can minimize the miscalculation of the relative contributions of productivity and input factors to economic growth.

2. Furthermore, the analysis by sub-periods might also shed some interesting results.

This is an interesting suggestion, and we will absorb it in the revised manuscript later. When we wrote this manuscript, we also considered that supplementary sub-periods analysis was a more comprehensive exploration of the provincial economic gap in China, but given that the time span of the sample is not very long, we didn't do that in the end.

As we know, the global sub-prime crisis that began in 2008 had an important impact on China's economic development. Considering this, are the sources of China's provincial economic gap different around 2008? Therefore, we will divide the entire period into two sub-periods in the subsequent revision of this paper, which is 1997-2007 and 2008-2016, and then perform a supplementary analysis to make up for the possible deficiencies in the analysis of the entire period.

3. In addition, I suggest add a table of variable definitions in section 3 and it will be more convenient for reader.

This is a good idea. In the revised version of this paper, we will add a variable definition column to Table 1, as shown in the following Table 1.

Table 1: Data: summary statistics

Variable	Definition	Unit	Maximum	Minimum	Median	Mean	Standard deviation
<i>GDP</i>	Gross domestic product	100 million yuan	58,191.70	205.68	4,930.48	10,218.15	12,542.62
<i>SO₂</i>	Industrial sulfur dioxide emissions	10,000 tons	149.67	1.69	35.03	41.61	29.07
<i>K</i>	Physical capital stock	100 million yuan	160,048.30	1,141.67	11,742.36	35,207.73	40,808.67
<i>L</i>	Employee	10,000 people	6,726.39	235.40	2,023.51	2,448.29	1,632.74
<i>H</i>	Human capital stock	year	8.92	2.94	4.48	4.50	1.03
<i>E</i>	Total energy consumption	10,000 tons of standard coal	26,933.33	390.30	6,035.52	7,412.75	5,612.80

Notes: All the data in the above table are collected by the authors. The *GDP* and physical capital stock data are respectively deflated with the *GDP* deflator and the fixed asset investment price index, and the base period is 2000.

4. There are problems in many sentences. Such as in section 2.2 “Labor productivity growth can be decomposed into TFP change TFPC (the product of the change in technological efficiency EC and technological progress TC)” ; in section 5.2 “In recent years, Kernel ……” . The quality of English needs to be improved.

Thank you for pointing out the errors. In this manuscript, we did not carefully check all sentences, and we will thoroughly check the language of this paper later.