PAPER • OPEN ACCESS

Drivers and decoupling situation analysis of Jiangxi's carbon emission

To cite this article: Junsong Jia *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **267** 032027

Drivers and decoupling situation analysis of Jiangxi's carbon emission

Junsong Jia[1,2,*], Xu Song[2,3], Min Ju[1,2] and Jing Lei[1,2]

[1]Key Laboratory of Poyang Lake Wetland and Watershed Research, Ministry of Education, Jiangxi Normal University, Nanchang, Jiangxi, 330022, China

[2]School of Geography and Environment, Jiangxi Normal University, Nanchang, Jiangxi, 330022, China

[3]Graduate School of Jiangxi Normal University, Nanchang, Jiangxi, 330022, China

[*]Corresponding author e-mail: jiaaniu@126.com

Abstract. Using the logarithmic mean Divisia index (LMDI) and Tapio model, we decomposed the drivers of carbon emissions (CE) from energy consumption (EC) in Jiangxi and analyzed the decoupling between economic growth and the CE during 2002-2017. The results showed that economic level effect was the decisive driver for the CE's increase. It brought about a cumulative contribution rate of 206.96% to the CE. Population size effect followed it, with the cumulative contribution rate of 9.58%. However, energy intensity had an obviously negative effect with the cumulative contribution rate of -114.34%. Energy structure had also a negative but not obvious effect with the cumulative contribution rate of -2.20%. Overall, a weak decoupling relationship between economic growth and total CE existed within the Jiangxi in 2002-2017. Namely, the economic development of Jiangxi was transformed into the low-carbon pattern, to a certain extent. Nevertheless, this pattern needed to be continually encouraged and strengthened. Therefore, it was necessary to take some measures to save energy or to reduce emissions while pursuing economic development. Especially, we should continue to improve energy efficiency through technological innovation, to adjust the energy consumption structure and to enlarge the proportion of clean energy, etc., in the long run.

1. Introduction

The issue of greenhouse effect and related carbon emissions (CE) has become one of the environmental concerns in the world. Especially, the decoupling relation between the economic growth level and carbon emissions has been attracted more and more attention in recent years. Wang and Chen (2015) found that the market, not the government, could determine the best way to decouple China's economic growth and energy consumption (EC) or CE [1]. Furthermore, Wang and Yang (2015) quantitatively analyzed the decoupling index of industrial economic growth and environmental pressure (indicated by the CE) in Beijing-Tianjin-Hebei region [2]. In addition, Zhou *et al* (2017) compared the decoupling effects' difference between carbon emissions and economic growth in China's eight major regions [3]. However, researches on the decoupling situation between carbon emissions and economic development in the relatively underdeveloped areas of China are still rare. Therefore, taking the Jiangxi Province as an example, we analyzed this decoupling relationship to scientifically and rationally formulate some concrete measures or suggestions for promoting regional sustainable development.

2. Data and method

2.1. Data sources
The data of energy consumption directly used for the estimation of carbon emissions are from Jiangxi Statistics Yearbook and China Energy Statistics Yearbook.

2.2. Method
The logarithmic mean Divisia index (LMDI) method used in this study is from Jia *et al* [4], and the decoupling analysis model used in this study is from Zhao *et al* (2017) [5].

3. Dynamics of carbon emissions
Figure 1 shows the total results of CE and EC of Jiangxi Province. From it, we could easily see that the total CE of Jiangxi Province increased from 20.96 million tonnes (Mt) in 2002 to 63.07 Mt in 2017. The growth amount reached 42.11 Mt, with the average annual growth rate of 13.39%. Similarly, the total EC increased from 29.33 Mt to 89.95 Mt during the period of 2002-2017, with the average annual growth rate of 13.8%.

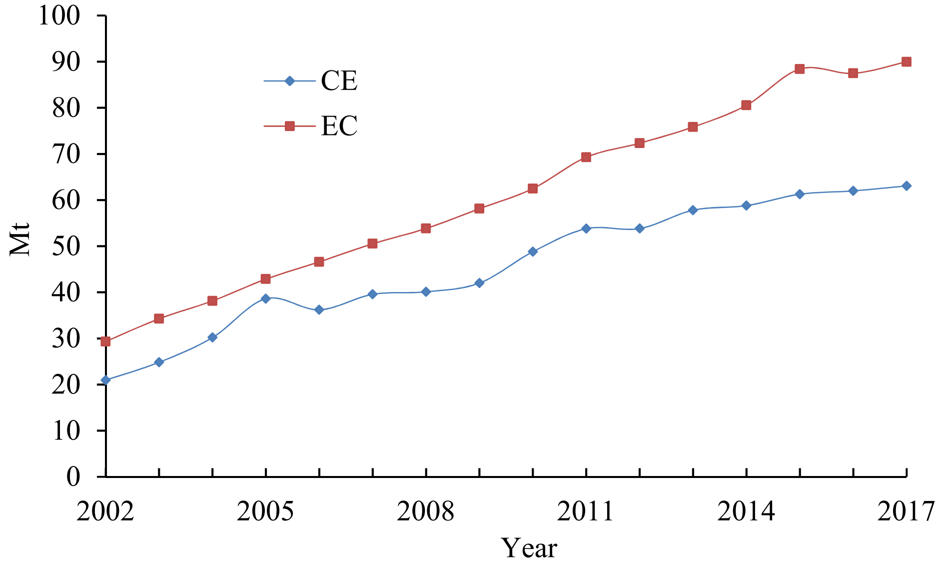

Figure 1. Total of CE and EC

It should be noteworthy that the growth rate of CE was greater than that of EC over 2002-2005. That was because the proportion of carbon-intensive fuels used like raw coal was getting larger and larger during 2002-2005. Nevertheless, in 2005-2008, the CE of Jiangxi Province grew up from 38.61 Mt to only 40.11 Mt. The average annual growth rate was 1.3%, which was significantly smaller than that of the EC (8.5%). That was because the proportion of carbon-intensive fuels used like raw coal was going down. Another reason might be arising from the global financial crisis, which just broke out in 2008 and directly restricted the use of some fuels such as raw coal, oil and gas. After 2008, the China's government had restarted massive investment and infrastructure construction projects which made the proportion of carbon-intensive fuels used like raw coal was getting larger and larger again during 2008-2011. Thus, the increase rate of Jiangxi's CE obviously grew up during 2008-2011. However, with the awareness' promotion of low-carbon development and environmental protection from the government and people's heart, clean energy (not the carbon-intensive fuels) had also developed faster and faster. Therefore, the growth rate of CE was, once again, obviously less than that of EC over 2011-2017.

4. Drivers
Figure 2 shows the cumulative contribution rate of different decomposition factors to the CE of

Jiangxi Province. It could be easily seen that the economic level effect was the decisive driving factor (driver) for the increase of CE in Jiangxi Province from 2002 to 2017. It brought about the annual average increasing amount of 5.81 Mt and the cumulative contribution rate of 206.96% to the total CE.

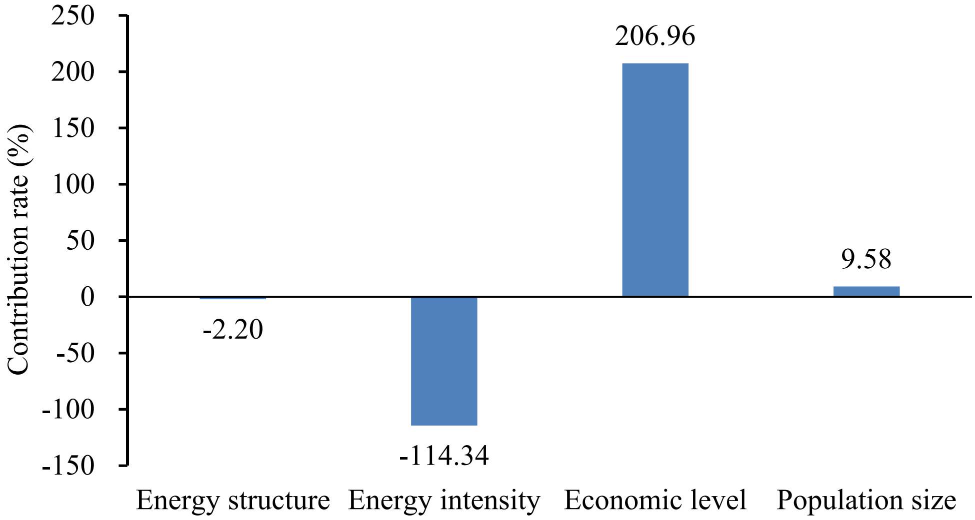

Figure 2. Cumulative contribution rate of different decomposition factors

Then, the population size effect was also an overall driver (although not very big) for the growth of CE, with the whole growth amount of 4.03 Mt and the cumulative contribution rate of 9.58% from 2002 to 2017. However, the energy intensity factor had an obviously negative effect to the total CE of Jiangxi Province in 2002-2017. It brought out the annual average decreasing amount of 3.21 Mt and the cumulative contribution rate of -114.34% to the total CE. Last, during the same period, the factor of energy structure also made a negative but not an obvious effect to the total EC. The correspondingly cumulative contribution rate to CE was -2.20%.

5. Decoupling situation analysis

Figure 3 shows the decoupling index changes of different decomposition factors and total CE. Based on the Tapio model [5], we could clearly see that an overall weak decoupling relationship between the economic growth and the total CE existed within the Jiangxi province in 2002-2017. During this studied period, the average annual growth rate of GDP in Jiangxi reached 47.76%, and the average annual growth rate of CE only reached 14.34%. So, the growth rate of GDP was significantly higher than the growth rate of CE, which guaranteed the overall weak decoupling relationship between the economic growth and the CE. First, the overall decoupling index was 1.27 during 2002-2003, which indicated that the total CE had an "expansive coupling" relationship with the economic growth. Namely, a same change trend existed between the economic growth and the overall CE. Both two factors influenced each other. Then, the decoupling index decreased to 0.92 during 2003-2004, which indicated that the total CE still had an "expansive connection" relationship with the economic growth. Next, the decoupling index increased to 1.60 during 2004-2005, which showed that the total CE had, once again, an "expansive coupling" relationship with the economic growth. So, it could be easily concluded that the development pattern of low-carbon economy of Jiangxi province was not ideal during 2002-2005. The main reason might be arising from the large-scale development of the secondary industry in Jiangxi province, which was propelled by the related government's policies such as these measures only focusing on GDP growth. In addition, the development of the entire society may be influenced by the Severe Acute Respiratory Syndromes (SARS), which broke out in 2003. Due to the SARS, people might spend more time in the diet health and security, thus ignoring the development of energy saving and low-carbon economy. So, people produced a lot of carbon emissions at the same time of economic development.

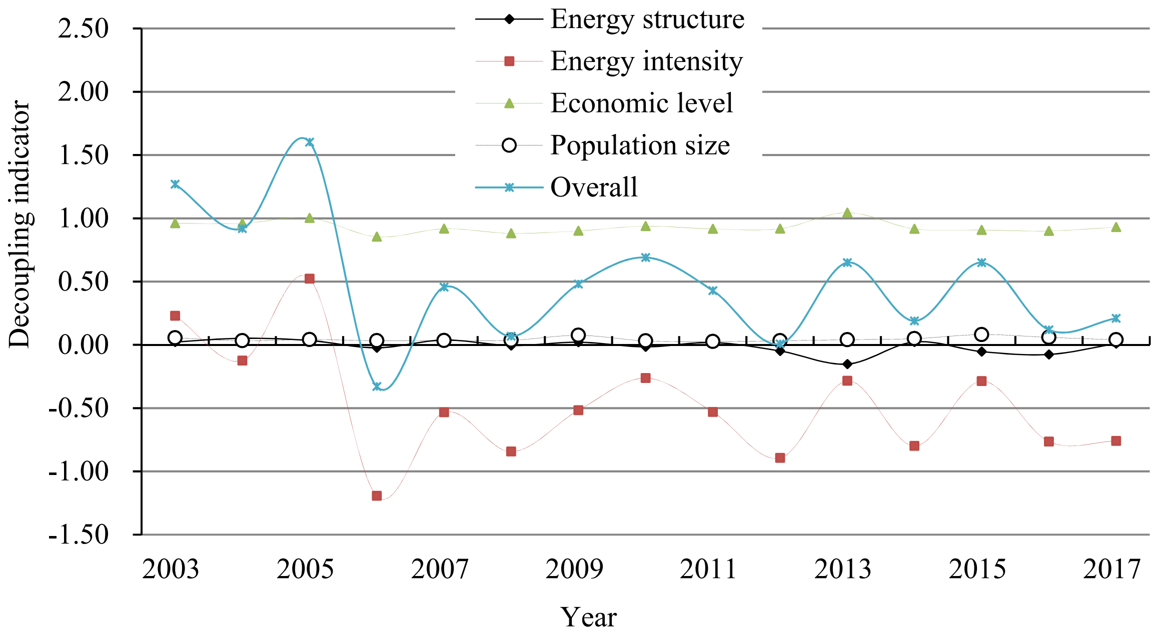

Figure 3. Decoupling index changes of different decomposition factors and total CE

However, after the SARS, the government began gradually to realize that the economic development pattern must be changed. Namely, people or society must go into the route of green, low-carbon, sustainable development mode. Thus, after a series of related policies' adjustments, the decoupling index decreased sharply to -0.33 during 2005-2006. So, the CE had an obvious decrease and the GDP still had a growth and the decoupling state presented a "strong decoupling" relationship, which showed a good and ideal decoupling result expected by us. Since then, the decoupling index remained in the range of 0-0.8. They were respectively 0.46, 0.07, 0.48, 0.69, 0.43, 0.01, 0.65, 0.19, 0.65, 0.12 and 0.21 from 2007 to 2017. These results indicated that the overall CE had always a "weak decoupling" relationship with the GDP growth during 2007-2017, which showed that the economic development mode of Jiangxi was transforming to the low-carbon pattern expected by us. However, people still needed to strengthen the implementation of related policies to guide this transformation. It should be mentioned that the decoupling index rose from 0.07 in 2008 to 0.48 in 2009, which showed that the "connection" of the overall CE and the GDP growth was growing up. The reason might be arising from the rapid development of infrastructure industry after the economic crisis, which broke out in 2008. During 2011-2017, the decoupling indexes were continually fluctuant, which showed a contradiction relationship between the rapid economic development and energy conservation or emission reduction in Jiangxi. Thus, effective measures should be taken to balance the relationship between the two factors.

From the decoupling index changes of different decomposition factors' point of view, the decoupling indexes of economic level effect and energy intensity effect were higher, but the indexes of population size effect and energy structure effect were lower. These results also showed that the first two factors (not the latter two) were the major drivers of the total CE of Jiangxi, which was consistent with the text above. The specific analysis results are as follows. The decoupling indexes of economic level effect basically maintained an overall declining trend. It decreased from 0.96 in 2003 to 0.89 in 2017 which indicated that the economic growth mode of Jiangxi province had begun to move from "extensive economy" to "intensive economy" based on the Tapio model [5]. At the same time, the decoupling indexes of economic level effect always fluctuated between 0.85 and 1.04 over 2003-2017, which indicated that the economic level effect was the most important factor affecting the total decoupling result of economic growth and the CE of Jiangxi. Thus, it was necessary and important for us to take some measures to save energy or reduce emissions while pursuing rapid economic development. The decoupling indexes of energy intensity effect had a large change as a whole. They were respectively 0.23, - 0.13, 0.52, -1.19, -0.53, -0.84, -0.52, -0.26, -0.53, -0.89, -0.28, -0.80, -0.29, -0.76 and -0.76 from 2003 to 2017. Thus, we could easily find that energy intensity effect played an extremely important role in suppressing the increase of the total decoupling index. Namely, the energy intensity effect was an indispensable factor in improving the decoupling state of economic growth and the CE of Jiangxi. This result could also be directly obtained from the decoupling trend of energy intensity effect, which was basically similar to the trend of the total decoupling. This result also implied that Jiangxi province should continue to improve energy efficiency and save energy for achieving the goal of emission reduction. The decoupling indexes of energy structure effect were respectively 0.02, 0.05, 0.03, -0.02, 0.04, -0.01, 0.02, -0.02, 0.02, -0.05, -0.15, 0.02, -0.05, -0.08 and 0.01 from 2003 to 2017. As a whole, they fluctuated between -0.15 and 0.05, and decreased from 0.02 in 2003 to 0.01 in 2017, which indicated that the energy structure effect had a certain role in promoting the decoupling of economic growth and the CE in Jiangxi, but its overall influence was relatively small. However, it was still necessary to continue to adjust the energy consumption structure and to enlarge the proportion of clean energy in the long run. The decoupling indexes of population size effect had always been positive, but it fluctuated only within in 0 - 0.08. They were respectively 0.06, 0.03, 0.04, 0.03, 0.03, 0.04, 0.08, 0.03, 0.03, 0.03, 0.04, 0.05, 0.06 and 0.08 from 2003 to 2017. These results indicated that population size had a weak effect on the decoupling of economic growth and the CE in Jiangxi.

6. Conclusions and discussion

Using the LMDI method, we decomposed the driving forces (drivers) of CE from Jiangxi's EC during 2002-2017. Then, through introducing the Tapio model, we analyzed the decoupling situation between economic growth and the CE. The results showed that the economic level effect was the decisive driver for the increase of CE. It brought about an annual average increasing amount of 5.81 Mt and a cumulative contribution rate of 206.96% to total CE. The population size effect followed it, with the cumulative contribution rate of 9.58%. However, energy intensity had an obviously negative effect to total CE. It led to an annual average decreasing amount of 3.21 Mt and a cumulative contribution rate of -114.34%. Energy structure had a negative but not obvious effect with the cumulative contribution rate of -2.20%.

Overall, a weak decoupling relationship between economic growth and total CE existed within the Jiangxi province in 2002-2017. But at first, the development pattern of low-carbon economy in Jiangxi was not ideal during 2002-2005. The reason might be, except for the SARS, arising from the large-scale development of the secondary industry in Jiangxi, which was propelled by the related government's policies such as these measures only focusing on GDP growth. However, after a series of related policies' adjustments into the route of green, low-carbon, sustainable development mode, the overall CE had always a "weak decoupling" relationship with the GDP growth during 2007-2017, which showed that the economic development mode of Jiangxi was transforming to the low-carbon pattern expected by us. However, people still needed to continually strengthen the implementation of related policies to guide this transformation.

In addition, the economic level effect was the most important factor affecting the total decoupling result of economic growth and the CE. Then, the energy intensity effect was also an indispensable factor in improving the decoupling state of economic growth and the CE. But, the energy structure effect had a relatively small role in promoting the decoupling relationship. And the population size had also a weak and almost negligible effect on this decoupling relationship between economic growth and the CE in Jiangxi. Therefore, it was necessary and important for us to take some measures to save energy or to reduce emissions while pursuing rapid economic development. Especially, we should continue to improve energy efficiency through technological innovation, to adjust the energy consumption structure and to enlarge the proportion of clean energy, etc., in the long run.

Acknowledgement

The financial supports of National Natural Science Fund (No. 71473113, 41001383) are gratefully acknowledged.

References

[1] Wang Q and Chen X 2015 *Renew. Sust. Energ. Rev.* **50** 470-479
[2] Wang Z H and Yang L 2015 *Ecol. Indic.* **48** 41-48
[3] Zhou X, Zhang M, Zhou M H and Zhou M 2017 *J. Clean. Prod.* **142** 783-800
[4] Jia J S, Gong Z H, Xie D M, Jian H Y and Chen C D in press *Energ. Effic.*
[5] Zhao X R, Zhang X, Li N, Shao S and Geng Y 2017 *J. Clean. Prod.* **142** 3500-3516