Modeling carbon emission pathways in China's regional level

–Based on ZSG-DEA and input-output technique

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Abstract: At present, China enhance its actions on climate change, which included the intention to low the carbon dioxide emissions per unit of GDP by 60–65% from the 2005 level. In order to complete the CO_2 emissions targets in 2030, China should consider maximizing the overall allocation efficiency of all regions and sectors. Therefore, this paper creatively uses the Network ZSG-DEA method in combination with Chinese inter-regional input-output table in 2007 to build the scientific distribution mechanism of binding CO_2 emission reduction target and to embody the difference in economic development, industrial structure and emission reduction potential among whole regions and sectors. Results show that: each region and sector will have different emission reduction path in the allocation of 2030 national carbon emissions reduction targets. Furthermore, several energy-intensive industries' reduction target will exceed national average standard, such as Mining Industry, Non-Mental Mineral Product Industry etc., which means those need to make more efforts to shift towards a low carbon development.

Key words: network-DEA; input-output technique; the efficiency of environmental production technology; emission reduction path

1 Introduction

Based on the intended nationally determined contributions (INDC), China has nationally determined its carbon emission actions by 2030 -- To lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level. Given the uneven levels of regional economic development as well as diverse energy-saving potential and energy consumption patterns in China, only national carbon reduction target is insufficient to depict the overall picture of CO_2 performance precisely. For achieving above ambition goals, it requires Chinese government to distribute the national target in regional level. It is obvious that even accomplish the same range of carbon emission reduction, the corresponding efficiency of carbon emission for each region or sector are completely different. In another word, the differentiation distribution mechanism of emission reduction targets in regional and sectoral level will cause a direct influence on policymaking, especially in the aspects of industrial adjustment and energy consumption. Therefore, studying the reasonable scheme for allocating the 2030 target and modeling the carbon emission pathways are practical significant to the formulation of proper economic and environmental policies.

A number of researchers devote to the related research of carbon emission. Currently, the accomplishment of CO_2 reduction target has already become a hot problem for scholars. Those studies mainly focused on three subjects, including emission reduction potential, synergy effect in carbon emission reduction and carbon emission peak reaching. In the study of emission reduction potential, Hickman and Banister(2007) estimated the possibility to meet a 60% CO_2 reduction target by 2030 in the UK transport sector. Which showed that the achievement of a carbon-efficient transport future, combined with holding travel levels and the emission reduction potential at present levels, is likely to be very difficult. [错误!未找到引用源。] Based on the Long-range Energy Alternatives Planning system (LEAP) model Özer et al.(2013) analyze the reduction of emissions in the electricity sector of Turkey, and indicated that in mitigation scenario , CO_2 emission intensity has decreased by 18.4% in 2030 compared to 2006, which can also achieve mitigation ratio of 17.5% over the simulation period. From the prospective of energy efficiency measures in cement and iron and steel industries, Iii et al.(2014) estimates the carbon reduction potential and its associated costs over the next twenty years.

In the study of synergy effect in carbon emission reduction, various scholars considered various problem. Considering the unclear nuclear future of Japan after

Fukushima Dai-ichi nuclear power plant accident, Su et al.(2014) assesses a series of energy consumption scenarios to analysis the synergy effect between the nuclear power and CO_2 emission reduction. Which concluded that it is ambitious for Japan to achieve the zero nuclear scenario with 30% CO_2 emission reduction. Chunark et al.(2014) analyzed the impacts of CO_2 reduction targets on Thailand's power sector and to determine equivalent carbon taxation under each reduction targets. In addition, some scholars investigate the effect of the change of economic structure on the emission reduction (Luukkanenet et al, 2015; Cui and Zhu, 2016; Li et al.,2012). They reach a consensus that achieving the CO_2 intensity target seems difficult. However, the constraints of reducing carbon emissions can be achieved, by using renewable energy, improving cleaner technologies and the marginal output of non-renewable energy.

As for the problem of reaching carbon emission peak: Wang et al.(2014) and Cheng and Xing et al.(2016) estimated the China's carbon emissions peak and its influence on the development of energy and power, which found that the key actions for inherently reducing the peak value are to control the total energy consumption and develop the clean energy. Some studies explored the nationally pathways of reaching carbon emission peak in various energy scenarios that explicitly simulates China's economic development, with a prospective consideration on the impacts of urbanization and income distribution. To reach the peak emission, as quickly as possible, current policies are not sufficient and a set of enhancement policy measures are highly recommended, such as energy system optimization, green-coal-fired electricity generation, and demand side management. (Yuan et al.,2014; Chai and Xu, 2015; Bi, 2015; Elzen et al.,2016) . These literatures mainly focus on the macro level in the whole country or in a single sector, which lack of integrality and systematical analysis for considering the connection among regions and sectors. Furthermore, in order to achieve the carbon intensity constraint in 2030, the policy maker should fully consider the fairness and efficiency in distribution mechanism for each region.

Considering the emission reduction targets in 2030, this paper will attempt to establish a new distribution mechanism in a more comprehensive manner, which aims at overall maximization of the carbon emission efficiency for all regions. Therefore, combining the theory of Input-Output technique and ZSG-DEA, the carbon emission ZSG-DEA model has been build, which can also embody the difference in economic development, industrial structure and emission reduction potential among regions and sectors. An empirical study of carbon emission pathways in Chinese regions and sectors using the above model are also presented. The rest of this paper is organized as follows. Section 2 introduces the carbon emission ZSG-DEA model, which combines with Input-Output technique. Section 3 presents the data used and the results obtained. Section 4 concludes this study.

2 Methodology

2.1 ZSG-DEA model with Input-Output technique

For allocating emission reduction targets in an efficient way, we use DEA method to modeling the carbon emission efficiency for different sectors among regions. Based on the carbon intensity target in 2030 emission, if we have a given GDP, the total amount of CO_2 can be regarded as a strong constraint and remain unchanged. In another words, all the carbon emission was increased (reduced) by one of the sectors must be reduced (increased) by the others, which is the net gains sum must equal zero, and these represent a situation similar to a zero sum game (ZSG).

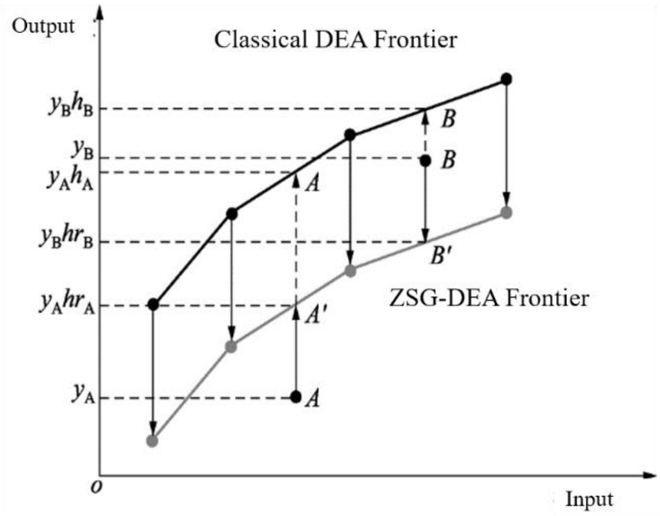

Figure 1 Schematic diagram of output based ZSG-network DEA principle

Gomes and Lins (2008) first put forward the ZSG-DEA model to propose a scenario regarding CO_2 emissions trade, following the Kyoto Protocol flexible mechanisms. Afterwards, according to “overall maximum efficiency” for each province during the 11th Five Year Plan period, Miao et al. (2013) applied the ZSG-DEA model to analyze the problem of non-radial efficiency allocation on energy intensity. They both use the strategies in DEA targets searching, with emphasis on the proportional reduction strategy (Lins et al., 2003). In opposition to what occurs to the classical DEA models, the way one DMU reaches its target in the efficient frontier implies changing the frontier (see in Figure 1). According to this strategy, the inefficient DMU searching for efficiency must lose some amount of input (or alternatively receive some quantity of output). In order to keep the total sum constant, the other DMUs must receive that amount of input (lose that quantity of output) proportionally to their original values of that input (output).

It is worth noting that the influence on the carbon emission efficiency of one sector for each region comes from two sides, not only other sectors in the same region, but also the sectors in different regions. Hence, different from other DEA research, we creatively combine the ZSG-DEA method with Input-Output technique, which is able to reflect the influence of complicated inter-industry relationship in carbon emission reduction. Therefore, in this paper, we establish the Carbon emission ZSG-DEA model, which can achieve the overall maximization of the carbon emission efficiency for all regions with a comprehensive distribution mechanism.

2.2 Carbon emission ZSG-DEA model

As Hu and Wang (2006) as well as many other studies did, they assume that there are three inputs, i.e. capital (*K*), labor (*L*) and energy (*E*) when formulate the carbon emission DEA model. Further, they assume that GDP and CO_2 emissions are specified as desirable and undesirable outputs, respectively. Unlikely, this paper considers the carbon emission as an essential productive factor, which regard as one of input in the model, instead of undesirable output. In addition, the intermediate input (Z_{jk}) and output (Z_{kj}) in multi-regional Input-Output Table also in the production technology set *T*. Therefore, the production technology can be described as:

$$T = \left\{ \left(L, K, E, CO_2, Z^K, GDP, Z^J \right) : (L, K, E, CO_2, Z^K)\, can\ produce\, (GDP, Z^J) \right\} \qquad (1)$$

The formulation (2) represents the carbon emission ZSG-DEA model, input-oriented, for the case that just one DMU searches for the efficient frontier and with one constant sum input. In this model, θ_{ri} is the sector *i* efficiency, it can also be called the efficiency of carbon emission. K_j, L_j, E_j, CO_{2j}, Z_{jk}, GDP_j and Z_{kj} are the inputs and outputs original values, respectively; GDP_i, Z_{ki}, K_i, L_i, E_i, CO_{2i} and Z_{ik}, are the outputs and inputs for the sector *i* ; λ_{ij} are sector contributions of the efficient projection. Moreover, $\sum CO_{2i}$ represent the total amount of carbon emission in national level. Under the restriction that carbon emission sum must be constant, if sector *i* increase

$CO_{2i}(1-\theta_{ri})$ amount of its carbon emission, other $N-1$ sectors must decrease that amount of carbon emission.

$$\min_{\theta,\lambda} \theta_{ri} \quad for \quad i=1,\ldots,N$$

s.t.

$$\begin{cases} \sum_{j=1}^{N} z_{jk}\lambda_{ij} \le z_{ik} \quad k=1,\ldots,N \\ \sum_{j=1}^{N} z_{kj}\lambda_{ij} \ge z_{ki} \quad k=1,\ldots,N \\ \sum_{k=1}^{N}\sum_{j=1}^{N} z_{kj}\lambda_{ij} = \sum_{k=1}^{N}\sum_{j=1}^{N} z_{jk}\lambda_{ij} \\ \sum_{j=1}^{N}\lambda_{ij}L_j \le L_i, \quad \sum_{j=1}^{N}\lambda_{ij}K_j \le K, \quad \sum_{j=1}^{N}\lambda_{ij}E_j \le E \\ \sum_{j=1}^{G}\lambda_{ij}CO_{2j}\left[1+\frac{CO_{2i}(1-\theta_{ri})}{\sum_{j\ne i}CO_{2j}}\right] \le \theta_{ri}CO_{2i} \\ \sum_{j=1}^{N}\lambda_{ij}GDP_j \ge GDP_i \\ \lambda_{ij} \ge 0 \end{cases} \tag{2}$$

In formulation (2), we can see that the carbon emission ZSG-DEA model is a non-linear multi-objective programming problem. This kind of problem usually needs metaheuristics to be solved. For the proportional reduction strategy, however, this model can be reduced to a non-linear mono-objective programming problem, as proved by the Proportional Strategy Theorem (Lins et al. 2003; Gomes, 2008). This theorem states that, the efficiency of DMUs in the ZSG-DEA model is directly proportional to their efficiency in the corresponding classical DEA model. Moreover, the target of the DMU under consideration in the ZSG-DEA model with proportional reduction strategy is equal to the target in the corresponding classical DEA model multiplied by a reduction coefficient.

Using above theorems and joint with corresponding classical carbon emission D EA model (see the detail in Appendix A), we can solve the formulation (2) via the linear relation in Equation (3).

$$\theta_{ri} = \theta_i\left[1+\sum_{j\in W}CO_{2j}\left(1-q_{ij}\theta_{ri}\right)\Big/\sum_{j\notin W}CO_{2j}\right] \tag{3}$$

Where, W is the cooperative set, which consists of the non-efficiency sectors in classical carbon emission DEA model. $q_{ij}=\theta_i/\theta_j$ is the proportionality factor that comes from the proportional strategy and θ_i, θ_j are the classical DEA efficiencies for sector. If all inefficient sectors comprise a single cooperation group and search for efficiency in the original DEA efficient frontier, ZSG-DEA model will promote the total redistribution/reallocation of the input (or output) with constant sum. After this reallocation, all the DMUs will belong to the efficient frontier, which is all sectors will be 100% efficient. Therefore, based on the constraint of emission reduction targets 2030, we can obtain the distribution mechanism that can achieve the "overall maximum carbon emission efficiency" for all sectors in each region.

3 Empirical Study

3.1 Data resource and Scenarios

Based on the official regional IO table published by National Bureau of Statistic (NBS) of China in 2007, this paper compiles the multi-regional IO table for eight regions (see the detail of region classification in Appendix B). From that table, we can get the intermediate input and output data. To predict the change of the relationship among sectors in different regions, we adjust the direct consumption coefficients every five years by choosing important coefficients with an influence approach[1]. The employment data comes from China's Statistic Yearbooks and 30 provinces statistical yearbook. The dataset contain the value of capital stock, which can be obtained by using the depreciation of fixed assets data form IO Table and the depreciation rate for each sector.

We used the accounting methods that applied in IPCC Guidelines for National Greenhouse Gas Inventories to estimate the carbon dioxide emissions from the combustion of fossil fuels for each region (Paustian et al.,2006). First, according to the China's Energy Statistical Yearbook, we can get the energy consumption data in of 20 energy of ten types energy classifications. Then, in order to construct the total energy usage data, we should remove the repeated counting of secondary energy and adjust the final energy consumption data by "energy balance table". Based on Chinese specific carbon emission factors and the IPCC reference approach, we can finally calculate the sectoral carbon emission in different regions.

According to the 13th Five-Year Plan, the roadmap for the nation's development from 2016 to 2020, China will lower its GDP growth target to keep a moderate-high speed increase. Therefore, in this paper, we set three economic development pattern, including medium, high and low speed growth. Combining the 2030 carbon intensity

[1] Detail methodology on the field of influence approach can be found in Sonis and Hewings(1992).

targets, we can ultimately get six scenarios in Table 1[2]. Due to the space limitations, we choose S2 Scenario to carry out the discussion and analysis.

Table 1 Scenarios in three development pattern

Scenarios	Targets 2020	Targets 2030	Development pattern	Period	GDP growth rate	Accession rate	Capital stock growth rate
S1	45%	60%	Medium speed (BAU)	2016-2020	7%	0	8.4%
				2021-2025	6.6%	0	7.8%
S2	45%	65%		2026-2030	5.9%	-0.3%	7%
S3	45%	60%	Low speed (Risk Scenarios)	2016-2020	5.7%	0	6.9%
				2021-2025	5.1%	0	6.1%
S4	45%	65%		2026-2030	4.3%	-0.3%	4.9%
S5	45%	60%	High speed (Growth Scenrios)	2016-2020	7.2%	0	7.5%
				2021-2025	6.6%	0	6.8%
S6	45%	65%		2026-2030	5.8%	-0.3%	5.5%

3.2 Efficiency allocation of China's 2030 carbon emission target

Using the carbon emission ZSG-DEA model for emission allocation calculation, the efficiency allocation amounts of CO_2 emission in Chinese regions can be obtained. The carbon emission efficiency value over 1 implies the region theoretically allow to increase its carbon emission, otherwise means to reduce its carbon emission. Although ZSG emissions and forecasted emissions of each region is different, but overall CO_2 emission in the limitation of emission reduction constraint remains unchanged, all regions are on the ZSG-DEA efficiency frontier and achieve "overall Pareto optimality". For the efficiency allocation mechanism, we find it mainly cause two changes: the carbon emission percentage for each regions and the contribution for each sectors.

Compare to 2010, the carbon emission percentage for each regions show difference in 2030. There will call for a strict implementation of carbon emission reduction for northern coast, eastern coast and central regions to achieve the 2030 target.

2 The scenarios setting scheme refers to Li (2010).

In Figure 2, we can see that the percentage for those regions need to decrease 5%-8% than 2010. However, for southwest and northwest regions, the percentage of carbon emission will increase, and southwest region increased mostly which is 10%. As to northern municipalities and northwest regions, those only show minimal growth, which about 1%. In addition, different sectors take different responsibility to accomplish the carbon emission reduction among regions. For instance, the allocation result shows that all sectors in northern municipalities need more emission reduction than in other regions.

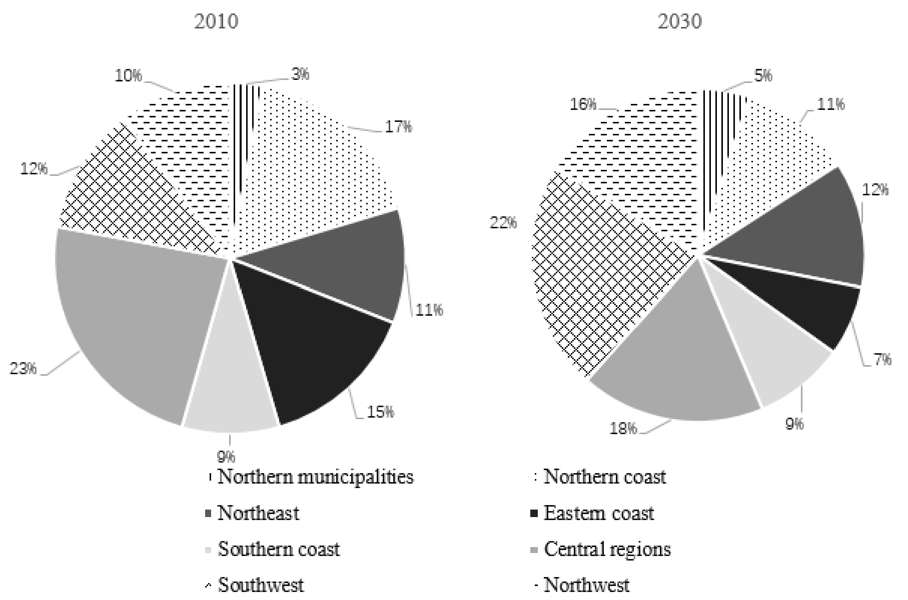

Figure 2 The percentage of carbon emission for eight regions in China on 2010 and 2030

On the other hand, various sectors (See sector classification in Appendix C) contribute to achieve the overall target in 2030 distinctively. There are higher standard for Light Manufacturing Industry in western coast and central regions and the energy-extensive consumption industries in northern coast, such as smelting and pressing of metals sector and nonmetal mineral products sector etc. In Table 2, we can see the sectors that reduction constraints of carbon intensity are exceed to the 65% level. The last column shows the exceeding rate. For example, the exceeding rate in first row is 9.9%, which means the nonmetal mineral products sector in northern coast must lower its carbon dioxide emissions per unit of sectoral GDP by 74.9% (65% add 9.9%) from the 2005 level.

Regions	Sectors	Exceeding rate
Northern coast	Nonmetal Mineral Products	9.9%
	Smelting and Pressing of Metals	9.3%
	Transportation	8.9%
	Trade and Catering Services	9.4%
Eastern coast	Primary	6.2%
	Extractive Industry	6.3%
	Light Manufacturing Industry	4.3%
	Nonmetal Mineral Products	5.4%
	Smelting and Pressing of Metals	4.6%
	Equipment Manufacturing Industry	5.1%
	Electricity, Heat, Water	4.8%
	Construction	6.0%
Central regions	Light Manufacturing Industry	6.5%
	Other Manufacturing	14%
	Electricity, Heat, Water	5.8%
	Transportation	5.3%
	Trade and Catering Services	7%
Northern municipalities	Other Manufacturing	3.6%

Table 2 High standard sectors based on the 2030 carbon emission target

3.3 The pathways of regional and Sectoral carbon emission in China

Due to the different resources endowment, industrial structure and energy consumption structure, it is obviously that pathway of regional carbon emission in China show diversity. In figure 3 and 4, we set the 65% carbon intensity targets in 2030 as an example, to illustrate the carbon emission performance among eight regions and several sectors from 2007 to 2030.

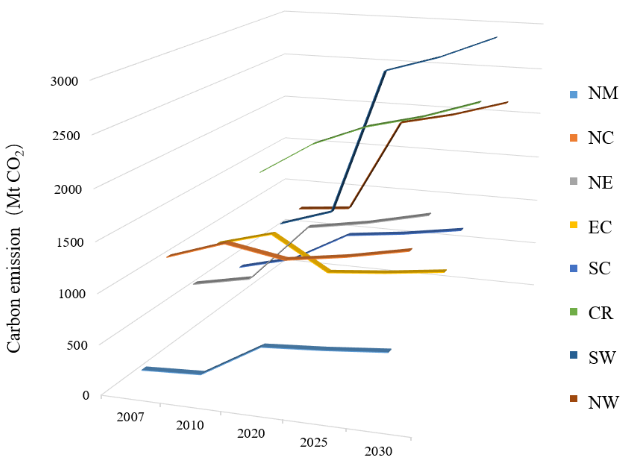

Figure 3 Carbon emission path during 2007-2030 for eight regions[3]

[3] See the region codes in Appendix A

We find that for achieving the 65% target, different regions must emit different amount of CO_2 in each year and show various tendency. In general, in the time of 2007 -2030 period, the CO_2 performance have trend higher for most regions, especially have a remarkable growth from 2010 to 2020. However, for northern coast, it is worth noting that the carbon emission continues to slowly drop from 2010, and then back on track with slow but steady growth in 2020. The northern coast region consists of the two high emission provinces: Shandong and Hebei. In 2010, the percentage of carbon emission in northern coast is 17.8%, which means that this region requires making many contributions to reach the emission-reducing target. In west coast, the declination of carbon emission is more significant during 2010-2020 and remain stable subsequently, which implies the industry structure that the second industry dominating with service industry being gradually on the rise.

In sectoral level, there are various carbon emission tendency among different sectors from 2007 to 2030. Except some energy-extensive consumption sectors, most sectors present a slowly increasing trend in carbon emission. For nonmetal mineral products sector, it falls dramatically during 2010-2020, and keep more or less steady. The sector of smelting and pressing of metals shows the different trend, which has an evident growth from 2007 to 2020 and become stable afterwards. Hence, the different trend of sectoral carbon emission not only reflect the diversity of energy-consumption efficiency and energy-saving potential for each sector, but also reflect the influence of industrial adjustment to the carbon emission changes.

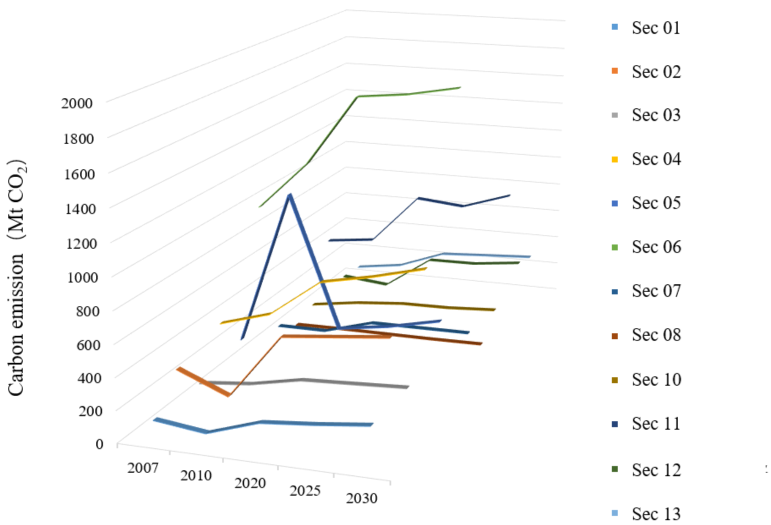

Figure 4 Carbon emission path during 2007-2030 for twelve sectors[4]

[4] See the sector codes in Appendix B

4 Conclusions and policy implications

Based on the theory of Input-Output technique and ZSG-DEA, this paper put forward the environmental production technology of emission allocation model, which aims at overall technical efficiency maximization of all regions. Considering the carbon emission reductions constraints in 2030, this model estimate carbon emissions of China's regions and sectors and perform efficiency allocation in regional and sectoral level. Moreover, based on the analysis of efficiency allocation mechanism from two aspects: carbon emission percentage for each regions and the contribution changes for each sectors, we explore the carbon emission pathways from 2007 to 2030.

Our results shows that: first, there are great gaps among regions and sectors in the efficiency allocation of emission reduction targets. In the long term, adjustment of the industrial structure may play an essential role in reducing the carbon emission for each region. Second, the carbon emission pathways show big difference among regions and sectors, despite achieve the emission reduction targets eventually. Comparing to the national level of carbon intensity reduction, individual sectors in some regions require more declination and face a serious challenge in achieving the target.

According to the above conclusions, feasible policy implications are proposed from the following three aspects:

First, considering the different resources endowment, industrial structure and environmental protection pressure, the regional administration distribution mechanism, which made by central government, should pay attention to the equilibrium and fairness. Furthermore, for high-level carbon emission regions, such as northern coast, it can achieve a remarkable effect in short term, but has a small emission reduction potential in the long run. Therefore, in order to achieve the carbon intensity constraint, the policy maker should fully consider the fairness and efficiency in distribution mechanism, objectively analyze the bottleneck and obstacles for each region in current and future stage.

Second, each region should not only reaches the basic standard, but also takes the carbon emission constraints as a low carbon economy transformation spur in necessary and correct attitude. According to the unique pathway of carbon emission, the local government need to make feasible regional economic and industrial accompanying policy to undertake the emission reduction task actively. Third, regions should enhance cross-regional cooperation in information, technology and other sources. Except for conventional approaches, such as technological innovation and industrial adjustment, each region could use the market means, especially builds regional and national carbon trading market to reduce the carbon emission effectively and complete the goal of low carbon development eventually.

Appendix A The Classical Carbon Emission DEA Model

$$\min_{\theta,\lambda} \theta_i \quad for \quad i=1,\dots,N$$

s.t.

$$\begin{cases} \sum_{j=1}^{N} z_{jk}\lambda_j \le z_{ik} \quad k=1,\dots,N \\ \sum_{j=1}^{N} z_{kj}\lambda_j \ge z_{ki} \quad k=1,\dots,N \\ \sum_{k=1}^{N}\sum_{j=1}^{N} z_{kj}\lambda_{ij} = \sum_{k=1}^{N}\sum_{j=1}^{N} z_{jk}\lambda_{ij} \\ \sum_{j=1}^{N} \lambda_{ij}L_j \le L_i, \quad \sum_{j=1}^{N} \lambda_{ij}K_j \le K_i, \quad \sum_{j=1}^{N} \lambda_{ij}E_j \le E_i \\ \sum_{j=1}^{N} \lambda_{ij}CO_{2j} \le \theta_i CO_{2i} \\ \sum_{j=1}^{N} \lambda_{ij}GDP_j \ge GDP_i \\ \lambda_{ij} \ge 0 \end{cases}$$

Note: Detail of the parameters explanation is in section 2.2

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Appendix B Region Classification and Codes in China

Regions	Provinces	Codes
Northeast	Liaoning, Jilin, Heilongjiang	NE
Northern municipalities	Beijing, Tianjin	NM
Northern coast	Hebei, Shandong	NC
Eastern coast	Shanghai, Jiangsu, Zhejiang	EC
Southern coast	Guangdong, Fujian, Hainan	SC
Central regions	Shanxi, Henan, Hubei, Hunan, Anhui, Jiangxi	CR
Southwest	Chongqing, Sichuan, Guizhou, Yunnan, Guangxi, Qinghai	SW
Northwest	Shannxi, Inner Mongolia, Ningxia, Gansu, Xinjiang	NW

Appendix C Sector Classification and Codes

Classification	**Sectors**	**Code**
Primary	Agriculture, Forestry, Animal Husbandry, Fishery and Water	Sec 01

Extractive Industry	Mining and Washing of Coal Extraction of Petroleum and Natural Gas Mining and Processing of Metal Ores Mining and Processing of Nonmetal and Other Ores	Sec 02
Light Manufacturing Industry	Manufacture of Foods and Tobacco Manufacture of Textile Manufacture of Leather, Fur, Feather and Related Products Manufacture of Timer and Furniture Manufacture of Paper and Educational and Sports Goods	Sec 03
Petroleum and Chemical	Processing of Petroleum, Coking, Processing of Nuclear Fuel Chemical Industry	Sec 04
Nonmetal Mineral Products	Nonmetal Mineral Products	Sec 05
Smelting and Pressing of Metals	Smelting and Pressing of Ferrous Metals Smelting and Pressing of Nonferrous Metals	Sec 06
Equipment Manufacturing Industry	Metal Products Manufacture of general purpose machinery Equipment for Special Purposes Transportation Equipment Electric Equipment and Machinery Manufacture of Communication Equipment, Computer and Other Electronic Equipment Measuring Instrument, Cultural and Office Machinery	Sec 07
Other Manufacturing	Manufacture of Artwork and Other Manufacturing	Sec 08
Electricity, Heat, Water	Production and Supply of Electric Power and Heat Power Production and Supply of Steam and Water	Sec 09
Construction	Construction Work	Sec 10
Transportation	Transportation, Storage, Post and Telecommunication Services	Sec 11
Trade and Catering Services	Retail Trade Services Wholesale Trade and Commission Trade Services Hotel and Restaurant Services	Sec 12
Others	Service	Sec 13

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