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Research on Impact of High Quality and Dual Circulation Development Pattern on Carbon Peak in Jiangsu Province

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Abstract: This study selected seven factors that affect Jiangsu Province's carbon emissions from the perspective of the high quality and dual circulation development pattern. GA-PSO-BP neural network was used to fit the carbon dioxide emissions of Jiangsu Province from 2000 to 2017, and predict the carbon emissions of Jiangsu Province from 2018 to 2035 under various development models, combined with the scenario analysis method. This study studied the impact of high quality and dual circulation development pattern on the carbon peak in Jiangsu Province from three aspects: economic society, scientific research and energy consumption, and dual circulation. It is found that the increase of the development rate of economic and social factors will slightly increase the peak of carbon dioxide in Jiangsu Province, but have no significant effect on the peak time. The rapid development of scientific research and energy consumption factors will reduce the carbon emission in Jiangsu Province and make the peak appear in advance. The rapid development of dual circulation factors will delay the emergence of the peak and increase its value. Policy recommendations were made for Jiangsu Province to achieve carbon peak at the end of the study.
Keywords: High quality and dual circulation development pattern, Improved BP neural network, Carbon dioxide emission

INTRODUCTION

As the largest developing country, China is committed to achieving peak carbon dioxide emissions by 2030. On the one hand, this is China's determination and responsibility; on the other hand, the high-quality development of implementing the new development concept of innovation, coordination, green, openness and sharing provides a realistic basis for China to achieve the carbon peak on schedule. In response to the high-quality development, in order to cope with the unprecedented changes in the world and give full play to the economic advantages of great powers, China proposes to build a new development pattern with the domestic big cycle as the main body and the domestic and international double cycles promoting each other.

The possibility and methods of achieving carbon emission reduction targets in China have attracted a large number of scholars' research enthusiasm. Zhao et al. (2021)studied the influence of different carbon accounting methods, driving factors and simulation on the realization of carbon peak in Shandong, Henan and Guangdong Province. Chai et al. (2022)predicted the carbon peak in Xinjiang under three scenarios. There are also studies evaluating the factors that have the greatest impact on China's carbon emissions from a large number of indicators(Shuai et al. 2018; Wei et al. 2019). Other studies have discussed the peaks of different sectors in China, such as the power industry (Tang et al. 2018; Wang et al. 2019)and tourism(Ma et al. 2021). Many studies use factors related to high-quality development to predict carbon emissions in China. For example, Pan et al. (2021)used STIRPAT model to fit the model of carbon emissions and six influencing factors of population, per capita GDP, urbanization rate, industrial structure, energy intensity and energy structure in eleven provinces and cities in eastern China, and then predicted carbon emissions. Hou et al. (2019)constructed the regression equation of carbon emissions in Liaoning Province by using six variables including total population, per capita GDP, urbanization rate, industrialization level, energy consumption intensity and non-fossil energy proportion. Xu(2019)applies dynamic nonlinear neural network to the prediction of China's carbon dioxide emissions. Eleven input variables are selected, including GDP, per capita GDP, total population, urbanization rate, the proportion of secondary industry, tertiary industry, total energy consumption, coal proportion, non-fossil energy proportion, energy productivity and environmental governance investment. Qiu and Cai (2019)used rough set to reduce the carbon emission factors in Shaanxi Province. Finally, eight indicators, including per capita GDP, population, industrialization level, urbanization rate, energy consumption per unit of GDP, coal consumption, forest area and construction land, were selected to predict carbon emissions in Shaanxi Province by neural network. When predicting carbon emissions, few studies regard indicators that can reflect the dual cycle development as variables, but it does affect carbon emissions. Xu (2014) forecasts that China's expansion of domestic demand will reduce carbon emissions by analyzing China' s 2007 input-output table. Through the GTAP-E model, Yu and Peng (2017) find that the policy of 'stimulating domestic demand' is implemented while adjusting the industrial structure. Some studies think that in the process of import and export trade, China is a net exporter of carbon, bearing the pressure of carbon emissions for other countries(Hu &Guo 2017; Sheng &He 2016), while Cao et al (2014) think China is a net importer of carbon, which means foreign trade has slightly reduced China's carbon emissions.

When selecting variables, this study takes into account high-quality and dual-cycle development, selecting population, urbanization rate, per capita GDP, research and development expenditure, total energy consumption, final consumption rate and foreign trade dependence as influencing factors, and takes Jiangsu Province, which is in the forefront of China's social development and foreign trade level, as the research object. By optimizing BP neural network, this paper explores the impact of the high quality and dual circulation development pattern on carbon peak in Jiangsu Province, enriches the research on green development in the Yangtze River Delta region, and provides reference for China to successfully achieve carbon peak goals under the new development pattern.

RESEARCH METHODS AND DATA SOURCES

Calculation of carbon dioxide emissions

According to the United Nations National Greenhouse Gas Emission Inventory Guidelines (IPCC 2006), this study uses the carbon emission coefficient method to calculate the carbon dioxide emissions of Jiangsu Province from 2000 to 2017.

$$A = \sum_{i=1}^{n} E_i \times C_i \times F_i \times \frac{44}{12} \qquad (1)$$

where A refers to carbon dioxide emissions of Jiangsu Province, i refers to the consumption of the ith energy, C_i refers to the standard coal coefficient of the ith energy, and F_i refers to the Carbon emission coefficient of the ith energy.

Carbon emission prediction model

BP neural network is a multi-layer neural network trained by error back propagation algorithm, which consists of input layer, hidden layer and output layer. The input layer receives information and transmits it to the hidden layer. The hidden layer processes the received information, and the output layer gives the results after training. BP neural network adjusts the weights and thresholds from input layer to hidden layer and from hidden layer to output layer by error back propagation algorithm, which can better reflect the functional relationship between input information and output information.

The particle swarm optimization algorithm originates from the foraging action of the bird swarm. By calculating the individual and group optimal fitness of the particle swarm, the speed and position of the particle are updated until the maximum number of iterations or the optimal solution is found.

Genetic algorithm is an optimization algorithm simulating biological evolution and natural selection. It increases population diversity through crossover and mutation and alleviates local optimum problem.

GA-PSO-BP algorithm introduces genetic algorithm to increase the diversity of particles and enhance the global convergence ability of particle swarm optimization algorithm, then obtains the global optimal value by the improved particle swarm optimization algorithm, which is used as the initial weight and threshold of BP neural network to improve the training speed and prediction performance of BP algorithm.

Data sources

This study selects the data from 2000 to 2017 as samples, and the variable data are from the "Jiangsu Statistical Yearbook" over the years. The final consumption rate refers to the proportion of final consumption to the GDP of the expenditure method, and the foreign trade dependence refers to the proportion of total import and export to GDP. In this study, crude oil, coke, gasoline, fuel oil, diesel oil, kerosene, coal and natural gas are selected to calculate carbon dioxide in Jiangsu Province over the years. All kinds of energy consumption come from China Energy Statistics Yearbook.

Model fitting

This study selects seven input variables including the number of permanent population, urbanization rate, per capita GDP, research and development expenditure, total energy consumption, final consumption rate and foreign trade dependence in Jiangsu Province to fit the carbon dioxide emissions in Jiangsu Province from 2000 to 2017. The historical data of the first 12 years are training data, and the data of the last 6 years are test data. According to experience, the number of nodes in the hidden layer of the neural network can be determined by the following equation.

$$n = \sqrt{i + o} + \alpha \qquad (2)$$

where n is the number of hidden layer nodes, i is the number of input layer nodes, o is the number of output layer nodes, α is a integer between 1 and 10.

In this study, the number of nodes in the input layer of the neural network is 7, and the number of nodes in the output layer is 1. Therefore, the appropriate number of hidden layer nodes is selected between 3 and 13. Based on the principle of minimum error, the number of hidden layer nodes is determined to be 5. The maximum number of neural network training is 500, the training target is 0.00001, and the learning rate is 0.01. The fitting effect of neural network is shown in Fig. 1.

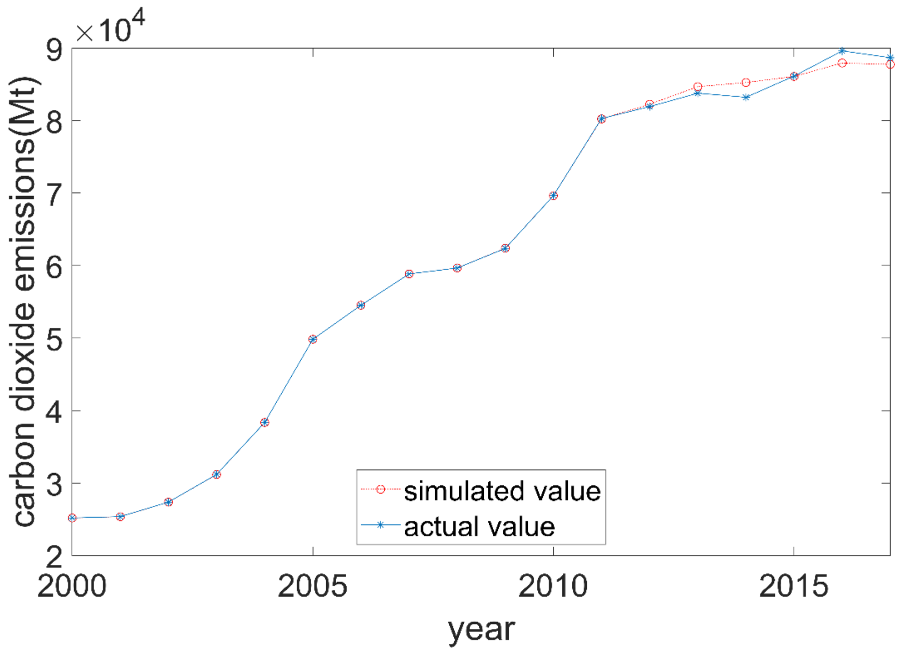

Fig. 1 Model fitting effect

As Table 1 shows, from 2012 to 2017, the maximum absolute relative error is 2.44%, the average absolute relative error is 1.15%, and the average absolute relative error from 2000 to 2017 is 0.40%. The simulated emission curve is basically consistent with the actual emission curve, and the simulation results are good, which can be used to predict the carbon dioxide emissions in Jiangsu Province.

Table 1 The fitting error

year	simulated value (Mt)	actual value (Mt)	absolute relative error
2000	25175.55	25186.07	0.04%
2001	25361.19	25370.32	0.04%
2002	27364.33	27369.00	0.02%
2003	31166.86	31185.36	0.06%
2004	38354.12	38352.71	0.00%
2005	49830.89	49829.87	0.00%
2006	54527.85	54525.74	0.00%
2007	58846.05	58844.09	0.00%
2008	59666.42	59659.30	0.01%
2009	62396.49	62371.06	0.04%
2010	69648.12	69649.55	0.00%
2011	80237.39	80291.80	0.07%
2012	82262.85	81933.09	0.40%
2013	84685.85	83776.48	1.09%
2014	85253.40	83218.82	2.44%
2015	86092.31	86140.63	0.06%
2016	87943.34	89621.10	1.87%
2017	87748.36	88685.55	1.06%

Scenario setting of influencing factors of carbon emission in Jiangsu Province

The seven influencing factors studied in this paper can be divided into three categories including economic and social factors, research and energy consumption factors and internal and external circulation factors. Economic and social factors include population, urbanization rate and per capita GDP; research and energy consumption factors include research and development expenditure and total energy consumption; internal and external circulation factors refer to final consumption rate and foreign trade dependence. In this study, the economic and social factors and research and energy consumption factors are used to reflect the high-quality development level of Jiangsu Province, and the internal and external circulation factors are used to reflect the dual circulation development level. This study set up a variety of scenarios according to the different rate of change of influencing factors. This paper sets three development scenarios for economic and social factors including low speed, benchmark and high speed. Innovation is at the core of China's modernization construction. China strictly implements the "double control" system of total energy consumption and intensity. This paper sets benchmark and high-speed scenario for research and development expenditure, corresponding to benchmark and low speed scenario for total energy consumption respectively. Finally, under the background of building a dual-cycle development pattern, this study sets benchmarks and high-speed development scenarios for internal and external circulation factors. According to different scenarios of economic and social factors, research energy consumption factors and internal and external circulation factors, twelve scenarios are obtained as Table **2**.

Table 2 Situational pattern design

sce-ne	high-quality development					double-cycle development	
	economic and social factors			research and energy consumption factors		Internalandexternal circulation factors	
	population	urbaniz-ation rate	per capita GDP	research and development expenditure	total energy consump-tion	final consum-ption rate	foreign trade depend-ence
L1	low	low	low	benchmark	benchma-rk	bench-mark	bench-mark
L2	low	low	low	benchmark	benchma-rk	high	high
L3	low	low	low	high	low	bench-mark	bench-mark
L4	low	low	low	high	low	high	high
M1	benchmar-k	benchm-ark	bench-mark	benchmark	benchma-rk	bench-mark	bench-mark
M2	benchmar-k	benchm-ark	bench-mark	benchmark	benchma-rk	high	high
M3	benchmar-k	benchm-ark	bench-mark	high	low	bench-mark	bench-mark
M4	benchmar-k	benchm-ark	bench-mark	high	low	high	high
H1	high	high	high	benchmark	benchma-rk	benchm-ark	bench-mark
H2	high	high	high	benchmark	benchma-rk	high	high
H3	high	high	high	high	low	benchm-ark	bench-mark
H4	high	high	high	high	low	high	high

Parameter settings

1) Population

The number of permanent residents in Jiangsu Province in 2018 and 2019 was determined by the "Jiangsu Statistical Yearbook 2020". The population data in 2020 came from the 13th Five-Year Plan for Population Development in Jiangsu Province. "National Population Development Plan (2016-2030)" predicts that the inertia of China's total population growth is weakening, reaching its peak around 2030. As Table 3 shows, referring to the historical rate of population change in Jiangsu Province, this paper sets the benchmark scenario for Jiangsu Province to grow by 0.4% in 2021-2025 and 0.3% in 2026-2030. In the low-speed scenario, the population growth rate was 0.3% in 2021-2025 and 0.2% in 2026-2030. Under the high-speed scenario, the population growth rate was 0.5 % in 2021-2025 and 0.4% in 2026-2030. In all scenarios, the population of Jiangsu Province decreased at an annual growth rate of -0.1% from 2031 to 2035.

Table 3 The annual population growth rate in Jiangsu Province under different scenarios

scenario	2021-2025	2026-2030	2031-2035
low	0.3%	0.2%	-0.1%
benchmark	0.4%	0.3%	-0.1%
high	0.5%	0.4%	-0.1%

2) Urbanization rate

The urbanization rates of Jiangsu Province in 2018 and 2019 are from the Statistical Yearbook of Jiangsu Province, and the data for 2020 are from the "Outline of the Fourteenth Five-Year Plan for National Economic and Social Development and the Vision 2035 Goals of Jiangsu Province". According to the "Fourteenth Five-Year" targets set by the Platform, the annual growth rate of Jiangsu Province in 2021-2025 was determined to be 0.82% under the benchmark scenario, and the growth rates slowed in 2026-2030 and 2031-2035. The growth rate of urbanization rate in high-speed and low-speed scenarios increases and decreases by 0.2% on the basis of the growth rate in the benchmark scenario, as Table 4shows.

Table 4 The annual growth rate of urbanization rate in Jiangsu Province under different scenarios

scenario	2021-2025	2026-2030	2031-2035
low	0.62%	0.42%	0.12%
benchmark	0.82%	0.62%	0.32%
high	1.02%	0.82%	0.52%

3) Per capita GDP

Jiangsu Statistical Yearbook shows the per capita GDP in 2018 and 2019, and the data in 2020 comes from "the fourteenth five-year plan of Jiangsu's national economic and social development and the long-term goal outline of 2035". According to the economic development goals of the outline, the growth rate of per capita GDP in 2021-2025 is set to be 5.5%, and the growth rates in 2026–2030 and 2031–2035 slow down. The growth rate of the two scenarios is up and down 1% based on the growth rate of the benchmark scenario. (Table 5)

Table 5 The annual growth rate of GDP per capita in Jiangsu Province under different scenarios

scenario	2021-2025	2026-2030	2031-2035
low	4.5%	4%	3%
benchmark	5.5%	5%	4%
high	6.5%	6%	5%

4) Research and development expenditure

The research and development expenditure of Jiangsu Province in 2018 and 2019 was obtained in the Jiangsu Statistical Yearbook. The data in 2020 were calculated according to the "Statistical Bulletin of National Economic and Social Development of Jiangsu Province in 2020". "The fourteenth five-year plan for national economic and social development of Jiangsu Province and the long-term goal outline for 2035" provide the growth target of R & D investment for the period of the fourteenth five-year plan, and set the annual growth rate of R & D expenditure under the benchmark scenario as 6.5%, and with the increase of R & D expenditure, the growth rate slowed down, and the annual growth rates of 2026-2030 and 2031-2035 under the benchmark scenario were 5.5% and 4.5%, respectively. The annual growth rate of the high-speed scenario is set to be 1% higher than that of the benchmark scenario. (

Table 6)

Table 6 The annual growth rate of research and development expenditure in Jiangsu Province under different scenarios

scenario	2021-2025	2026-2030	2031-2035
benchmark	6.5%	5.5%	4.5%
high	7.5%	6.5%	5.5%

5) Total energy consumption

The total energy consumption of Jiangsu Province in 2018 and 2019 is obtained from the Jiangsu Statistical Yearbook. The Center for Strategic and Development Studies of Jiangsu Province forecasts the total energy consumption of Jiangsu Province in 2020 and 2025(Lai et al. 2021). Based on this, the growth rate of energy consumption in Jiangsu Province in 2021-2025 is set to be 2.78%, and the growth rates in 2026-2030 and 2031-2035 continue to decrease. Jiangsu strictly implements the "double control" system of total energy consumption and intensity, and sets the low-speed scenario of total energy consumption outside the benchmark scenario, as Table 7shows.

Table 7 The annual growth rate of total energy consumption in Jiangsu Province under different scenarios

scenario	2021-2025	2026-2030	2031-2035
low	2.28%	1.78%	1.28%
benchmark	2.78%	2.28%	1.78%

6) final consumption rate

China is accelerating the formation of a new dual-cycle development pattern dominated by the domestic big cycle. The final consumption rate of Jiangsu Province in the future has two development scenarios: benchmark and high speed. According to the State Council Development Research Center macro report, China's consumption rate will rise to about 60% during the "14th Five-Year" period. Xu et al. (2020)forecast China 's consumption rate to rise to 58%-60% in 2025, corresponding to increasing rate of 0.64% and 1.07% in 2018-2025. This paper sets the growth rate of Jiangsu Province from 2018 to

2020 as 0.64%, and obtains the final consumption rate of Jiangsu Province in the three years. Under the standard scenario, the growth rate of the final consumption rate in 2021-2025 is 0.64%, and then the growth rate decreases. This study sets the growth rate of the final consumption rate in 2021–2025 under the high-speed scenario as 1.07%, as Table 8shows.

Table 8 The annual growth rate of final consumption rate in Jiangsu Province under different scenarios

scenario	2021-2025	2026-2030	2031-2035
benchmark	0.64%	0.54%	0.44%
high	1.07%	0.97%	0.87%

7) foreign trade dependence

The foreign trade dependence of Jiangsu Province in 2018 and 2019 is calculated by the relevant data in Jiangsu Statistical Yearbook, and the data in 2020 is calculated by the statistical bulletin on national economic and social development of Jiangsu Province in 2020. Compared with the United States and Japan, China's foreign trade dependence is higher, but it has continued to decline since 2011(Guo 2020). Referring to the historical rate of change, the change rate of foreign trade dependence in Jiangsu Province from 2021 to 2025 is -1.85% under the benchmark scenario, and the change rate is -2.45% under the high-speed scenario. With the decrease of foreign trade dependence, the decline slowed down. (Table 9)

Table 9 The annual growth rate of foreign trade dependence in Jiangsu Province under different scenarios

scenario	2021-2025	2026-2030	2031-2035
benchmark	-1.85%	-1.55%	-1.35%
high	-2.45%	-2.15%	-1.95%

RESULTS AND DISCUSSION

Peak value and peak time in all scenarios

The influencing factors of 12 scenarios were input into the trained GA-PSO-BP neural network to obtain the carbon dioxide emissions of Jiangsu Province from 2018 to 2035 under each scenario model, as Fig. 2shows.

The peak time and peak value of 12 scenarios are as

Table 10shows. Under the 12 scenarios, Jiangsu Province can reach its carbon peak by 2035, with a peak of 90248.35 to 933.415 million tons, and reach its carbon peak by 2030 under the 7 scenarios of L1, L3, L4, M1, M3, H1 and H3. L3 scenario had the earliest peak time and the smallest peak; the peak time of H2 scenario is the latest and the peak is the largest.

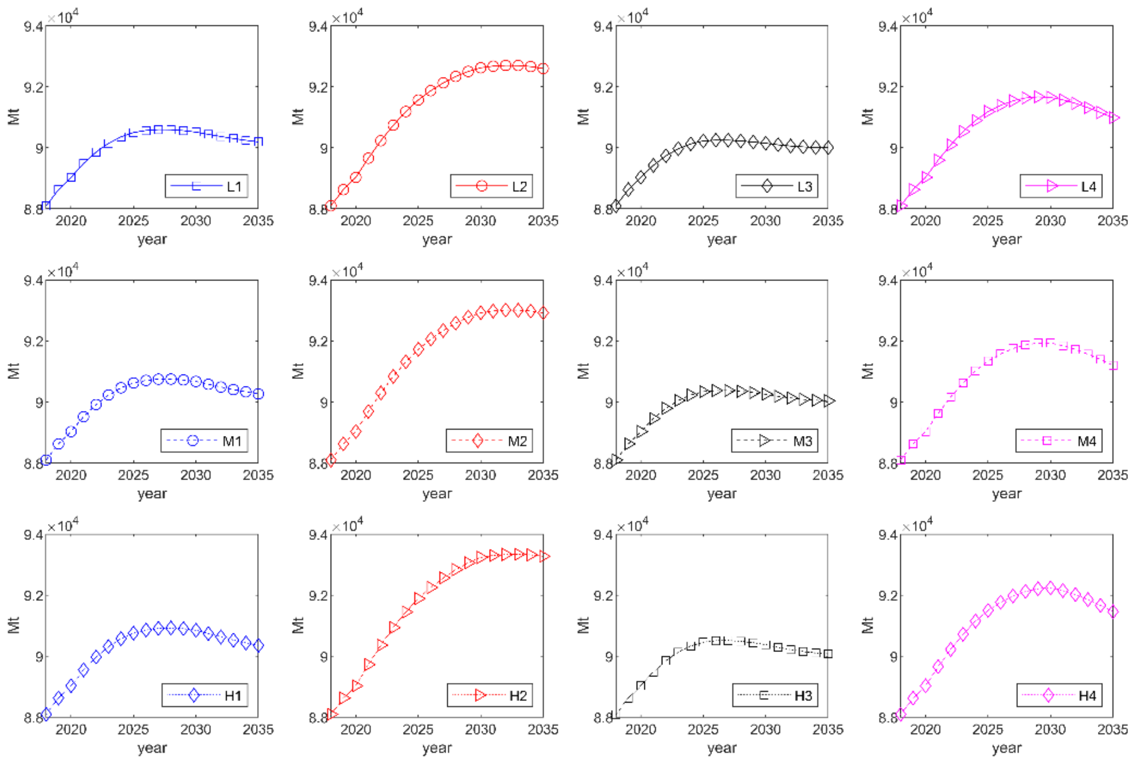

Fig. 2Carbon emission prediction under different scenarios in Jiangsu Province

Table 10 Peak time and peak value of each scene mode

scenario	peak time	peak value(Mt)
L1	2027	90593.65
L2	2032	92697.30
L3	2026	90248.35
L4	2029	91667.77
M1	2028	90748.52
M2	2032	93008.35
M3	2027	90374.61
M4	2030	91933.42
H1	2028	90922.04
H2	2033	93340.15
H3	2027	90513.36
H4	2030	92239.85

Effects of various factors on carbon peak

1) Impact of economic and social factors on carbon peak in Jiangsu Province

From Fig. 3, we find that when other factors are unchanged, with the increase of the development rate of economic and social factors, carbon emissions in Jiangsu Province increase, the peak value increases slightly, and the peak time is almost unchanged. Table 11shows the changes in the size and time brought by changing the development rate of economic and social factors to the peak of carbon emissions when other factors remain unchanged.

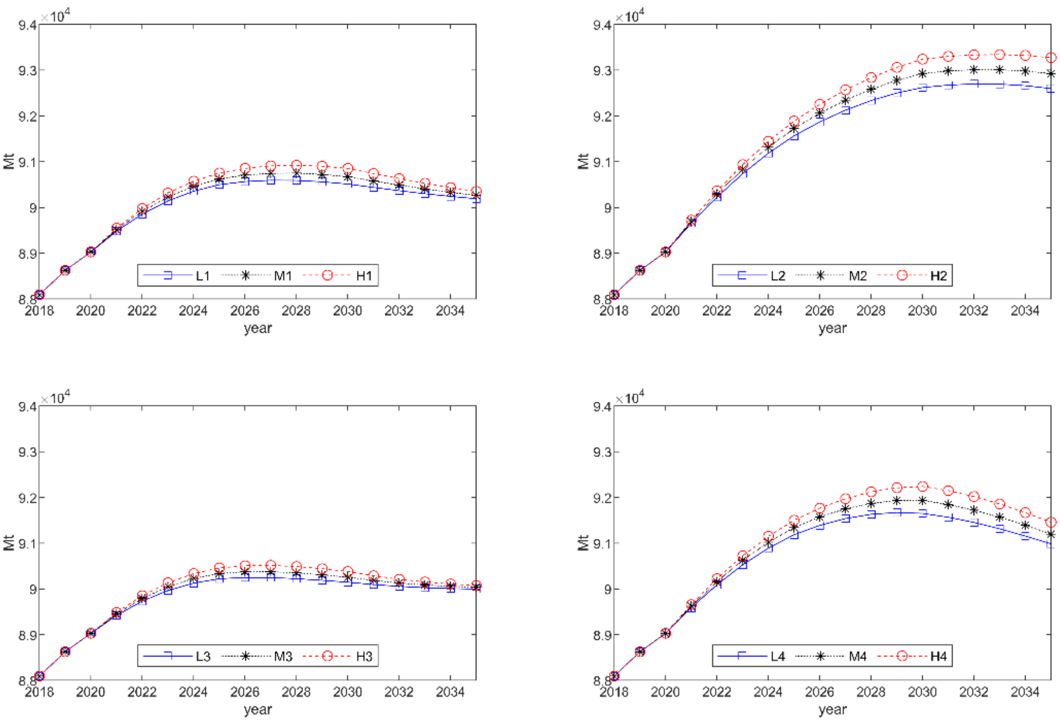

Fig. 3 Impact of economic and social factors on carbon emissions in Jiangsu Province

Table 11 Influence of economic and social factors on carbon peak in Jiangsu Province

Research and energy consumption factors	Internal and external circulation factors	Economic and social factors	Peak value (Mt)	Change of peak value	Rate of change	Peak time
Benchmark	Benchmark	low	90593.65	-154.87	-0.17%	2027
		benchmark	90748.52	/	/	2028
		high	90922.04	173.52	0.19%	2028
Benchmark	High	low	92697.30	-311.05	-0.33%	2032
		benchmark	93008.35	/	/	2032

		high	93340.15	331.80	0.36%	2033
High	Benchmark	low	90248.35	-126.26	-0.14%	2026
		benchmark	90374.61	/	/	2027
		high	90513.36	138.75	0.15%	2027
High	High	low	91667.77	-265.65	-0.29%	2029
		benchmark	91933.42	/	/	2030
		high	92239.85	306.43	0.33%	2030

When other factors remain unchanged, the change in the growth rate of economic and social factors will lead to the change of carbon dioxide peak in Jiangsu Province on the basis of the benchmark scenario ranging from -0.33% to 0.36%, but the change has little effect on the peak time.

2) Impact of research and energy consumption factors on carbon peak in Jiangsu Province

As Fig. 4 shows, when the development speed of economic and social factors along with internal and external circulation factors are constant, with the increase of research and development expenditure and the decrease of total energy consumption, carbon emissions in Jiangsu Province are reduced, the peak value is reduced and the peak time is advanced. Table 12 shows the changes in the size and time of carbon emission peak caused by changing the development rate of research and energy consumption factors when other factors remain unchanged.

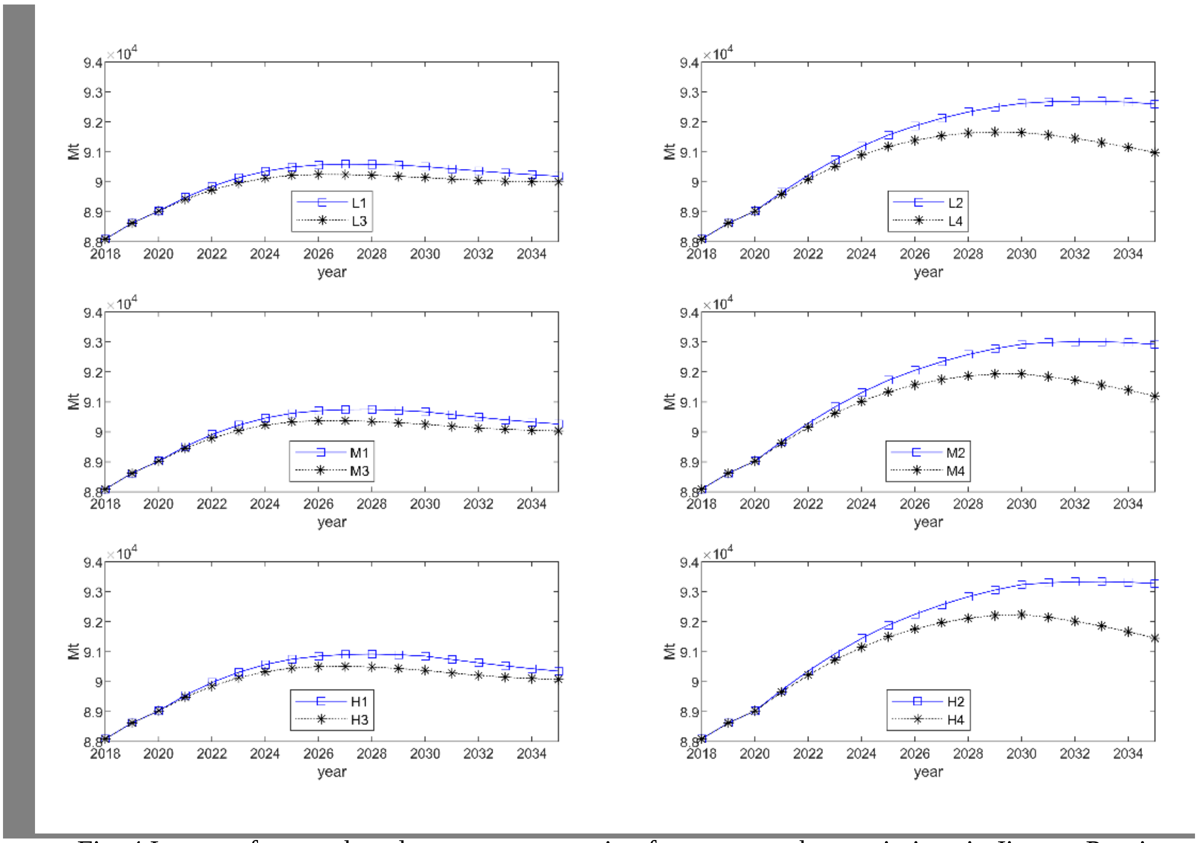

Fig. 4 Impact of research and energy consumption factors on carbon emissions in Jiangsu Province

Table 12 Influence of research and energy consumption factors on carbon peak in Jiangsu Province

economic and social factors	internal and external circulation factors	research and energy consumption factors	peak value (Mt)	change of peak value	rate of change	peak time
low	benchmark	benchmark	90593.65	/	/	2027
		high	90248.35	-345.30	-0.38%	2026
low	high	benchmark	92697.30	/	/	2032
		high	91667.77	-1029.53	-1.11%	2029
benchmark	benchmark	benchmark	90748.52	/	/	2028
		high	90374.61	-373.91	-0.41%	2027
benchmark	high	benchmark	93008.35	/	/	2032

		high	91933.42	-1074.93	-1.16%	2030
high	benchmark	benchmark	90922.04	/	/	2028
		high	90513.36	-408.68	-0.45%	2027
high	high	benchmark	93340.15	/	/	2033
		high	92239.85	-1100.30	-1.18%	2030

When other factors remain unchanged, the rapid development of research and energy consumption factors will reduce the peak value of carbon dioxide by 0.38% to 1.18% on the basis of the baseline scenario, and make the carbon peak time advanced by 1 to 3 years.

3) Impact of internal and external circulation factors on carbon peak in Jiangsu Province

As Fig. 5shows, when the economic and social factors and research and energy consumption factors remain unchanged, with the improvement of the development rate of internal and external circulation factors, carbon emissions in Jiangsu Province increase, the peak value increases and the peak time delays. Table 13 shows the scale and time changes brought by changing the development rate of internal and external circulation factors to the peak of carbon emissions when other factors remain unchanged.

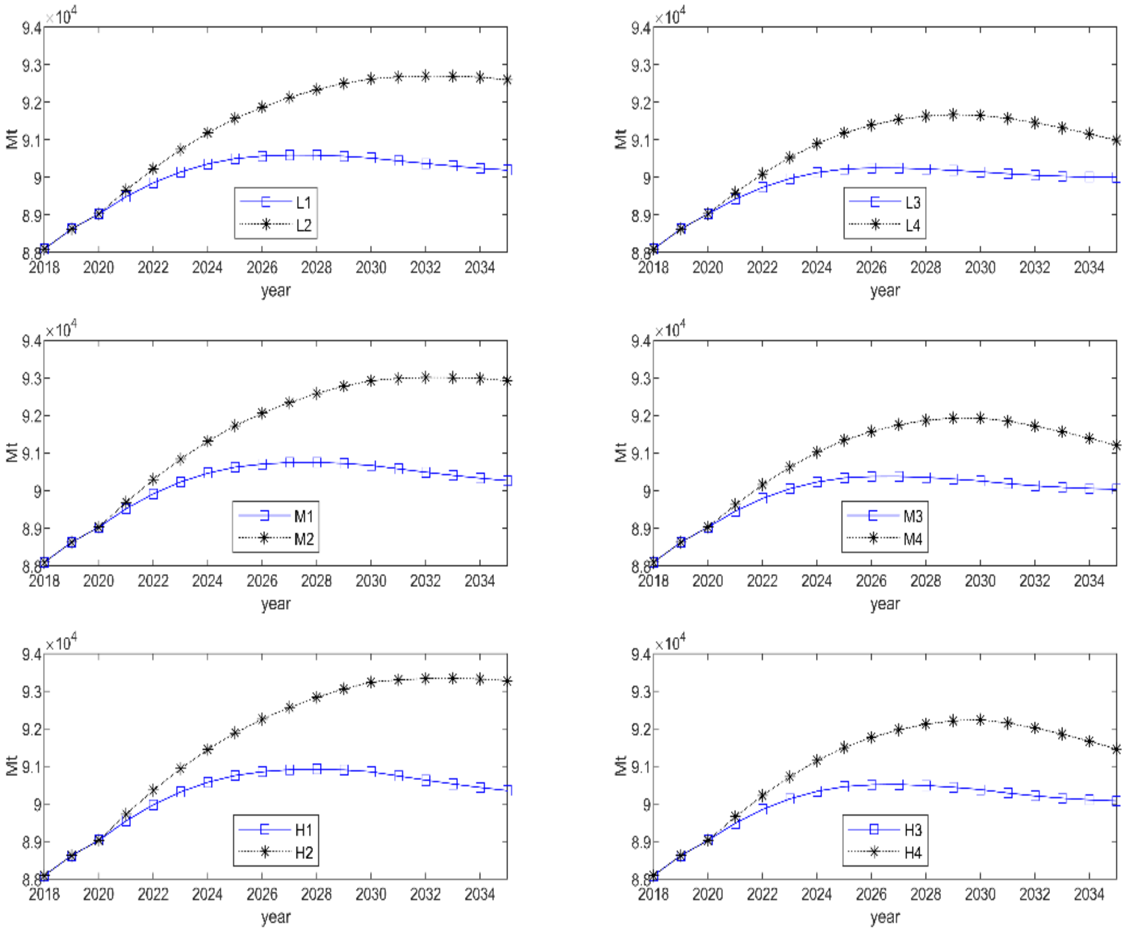

Fig. 5 Impact of internal and external circulation factors on carbon emissions in Jiangsu Province

Table 13 Influence of internal and external circulation factors on carbon peak in Jiangsu Province

economic and social factors	research and energy consumption factors	internal and external circulation factors	peak value (Mt)	change of peak value	rate of change	peak time
Low	Benchmark	benchmark	90593.65	/	/	2027
		high	92697.30	2103.65	2.32%	2032

Low	High	benchmark	90248.35	/	/	2026
		high	91667.77	1419.42	1.57%	2029
Benchmark	benchmark	benchmark	90748.52	/	/	2028
		high	93008.35	2259.83	2.49%	2032
Benchmark	high	benchmark	90374.61	/	/	2027
		high	91933.42	1558.81	1.72%	2030
High	benchmark	benchmark	90922.04	/	/	2028
		high	93340.15	2418.11	2.66%	2033
High	high	benchmark	90513.36	/	/	2027
		high	92239.85	1726.49	1.91%	2030

When other factors remain unchanged, the rapid development of internal and external circulation factors will increase the peak value of carbon dioxide by 1.57% to 2.66% on the basis of the benchmark scenario, and delay the carbon peak time by 3 to 5 years.

CONCLUSION

Among the twelve scenarios, Jiangsu Province can reach its peak before 2030 under seven development models. In the L3 scenario, carbon emissions in Jiangsu Province peaks at 90.24835 million tons in 2026, which is the smallest peak value and the earliest peak time. Without inhibiting the development rate of economic and social factors, the peak time of the optimal scenario M3 is 2027, with a peak of 90.37461 million tons. In this scenario, economic and social factors are in the benchmark scenario, research and energy consumption factors is in the high-speed scenario, and internal and external circulation factors are in the benchmark scenario.

When other influencing factors remain unchanged, increasing the growth rate of economic and social factors, namely resident population, urbanization rate and per capita GDP, will lead to the delay of achieving carbon peak in Jiangsu Province and the increase of carbon emissions. But population, urbanization rate and per capita GDP under different development scenarios have little effect on the peak and peak time of carbon emissions in Jiangsu Province. Keeping the development speed of economic and social factors in Jiangsu Province in a reasonable range can successfully achieve emission reduction targets.

When other factors remain unchanged, the high-speed growth of research and development expenditure and the low-speed growth of total energy consumption will make the peak time of carbon in Jiangsu Province advance and the peak value decrease. Jiangsu Province should increase investment in science and technology, develop energy saving and emission reduction technology, and promote the use of energy saving technology in production and life, safely and steadily promote the construction of Tianwan nuclear power plant and wind power industry base, develop clean energy and control energy consumption.

When the final consumption rate rises faster, foreign trade dependence decreases faster and other influencing factors remain unchanged, the peak value of carbon emissions in Jiangsu Province increases and the peak time is delayed. Jiangsu Province can improve the consumption willingness of residents by improving the quality of supply and strengthening social security, so as to improve the final consumption rate, cultivate residents' low carbon consciousness and reduce carbon emissions in daily life. At the same time, the government should support and promote enterprises to break through to the high-end industrial chain, enhance the added value of export products, reduce carbon emissions in the processing of export products.

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