THE STUDY OF THE IMPACT OF TECHNOLOGY ADVANCE ON CHINA'S ENERGY CONSUMPTION PER UNIT GDP

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Keywords: Technology advance， Energy consumption， Gray correlation analysis，Multiple linear regression，GM (1.1).

Abstract

Since China's reform and opening, with the rapid development of the heavy manufacturing and high energy consumption industry, energy consumption also increases significantly. However, in the energy consumption process, out-dated technology lead to high energy consumption of the unit GDP and the environmental pollution, which have directly influenced the sustainable development of China's energy consumption, economy and society. In order to ensure China's energy consumption, economic and social sustainable development, we should put more technology into the energy consumption to realize the changes towards tech-intensive China's energy consumption and the goal of China's 11th Five-Year Plan that average energy consumption per unit GDP decline 20%.

Therefore, on the basis of analyzing the actuality of China's energy consumption per unit GDP and technology advance, first the paper sums up 14 indexes which impact China's technology advance and sets up a comprehensive assessment system on China's technology advance; second it uses gray correlation analysis to select the key technology indexes which have an important impact on China's energy consumption constitution, and builds a multiple linear regression model for analyzing the connection between technology advance and China's energy consumption; Finally it uses GM (1.1) gray prediction model to select the optimum technology inputs decision-making which can realize the goal of China's 11th Five-Year Plan that average energy consumption per unit GDP decline 20%, in order to provide theoretical support for the relevant departments.

1 Introduction

Nowadays with the rapid advancement of technology, China's energy consumption gross is bound to increase, and China's energy consumption per unit GDP is bound to reduce, when the reducing rate of the energy consumption per unit GDP exceeds its growth rate, it can promote sustainable development of China's energy consumption and lead to change in energy structure. In this context, the study on the impact of technology advance on China's energy consumption can provide theoretical support for the relevant government departments setting down technology policy and energy consumption policy, and give strategic decisions for the implementation of China's 11th Five-Year Plan.[1~2]

2 The existing state on China's energy consumption per unit GDP and technology advance

2.1 The existing state on China's energy consumption per unit GDP

China's energy consumption per unit GDP shows an annual decline, the annual average drop is 3.79%, from 2002 to 2003 the technology advance lagged behind the large-scale energy need expansion which heavy industry development arose, which caused China's unit energy consumption increase. Since 2003 China's energy consumption per unit GDP has been falling, indicating that China's technology level gets an increased recovery. Look at Fig. 1:

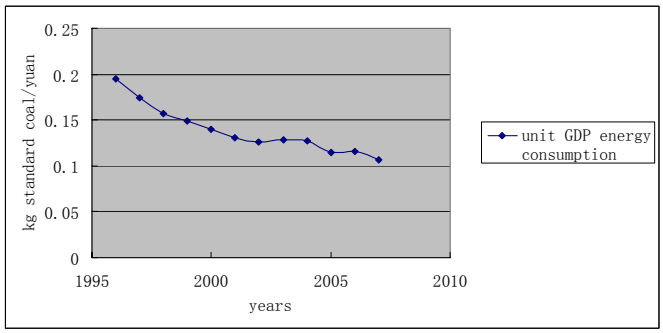

Fig. 1 China's energy consumption per unit GDP (1997~2007)[3]

2.2 The existing state on China's technology advance

We analyze China's technology advance actuality from the implementation modes of the technology advance. In general, technology advance has two implementation modes: ①

investing in research and development (R&D) by oneself, ② relying on technology imports. [4]

China's research and development expenditures have been moving up from 1996 to 2007 continually, the proportion of R&D to GDP rose from 0.6% in 1996 to 1.49% in 2007, which reflects that China attaches importance to technology advance.

China's technology imports mainly consult the following indexes: technology introducing expenditure and the digestive absorption expenditure caused by large and medium-sized industrial enterprises' technology activities which shows a wave shape from 1999 to 2007, and a quick growth in two years.

3 The assessment of technology advance's impact on China's energy consumption per unit GDP

3.1 The foundation of technology advance indexes system

Technology advance indexes are in the principles of comprehensiveness, maneuverability, independence, systematicness, and comparability to set up China's technology advance indexes from technical inputs and outputs. [5~6]

For the technology inputs, we should consider three aspects, the first is staff, the second is R&D expenditures, and the third is technology activity. In the staff aspect, we select technology activity personnel (X1), R&D personnel (X2), technology personnel of large and medium-sized industrial enterprises technology activity (X3), technology agency activity personnel (X4); In the R&D expenditure aspect, we select the R&D expenditures (X5), R&D/GDP(X6), R&D of large and medium-sized industrial enterprises technology activity (X7); In the technology activity aspect, we select the R&D enterprises number of large and medium-sized industrial enterprises technology activity (X8), the R&D enterprises number of large and medium-sized industrial enterprises technology activity/all the enterprises (X9), the institutions number of large and medium-sized industrial enterprises technology activity of (X10).

For the technology outputs, we mainly select the number of technology achievements award (X11) (including the number of technology achievements registration, the state technology invention award, national technology progress award), the number of patent applications admissibility (X12), the number of patent applications authorization (X13), technology market turnover (X14).

	1997	**1998**	**1999**	**2000**	**2001**
10000personsX1	288.6	281.4	290.6	322.3	314.1
10000persons X2	83.1	75.5	82.2	92.2	95.6
10000persons X3	147.4	141	145.3	138.7	136.8
10000persons X4	37.8	41.1	42	44	47.5
a hundred million yuan X5	481.5	551.1	678.9	895.7	1042.5
% X6	0.64	0.69	0.83	1	1.07
a hundred million yuan X7	214.4	232.2	249.9	353.4	442.3
Entries X8	7732	7220	7120	6187	6000
% X9	32.2	30.6	32	28.5	26.2
Entries X10	11142	10926	11237	7601	7400
Entries X11	31141	29127	31605	33131	28653
piece X12	114208	121989	134239	170682	203573
piece X13	50992	67889	100156	105345	114251
a hundred million yuan X14	351	436	523	651	783
2002	**2003**	**2004**	**2005**	**2006**	**2007**
322.2	328.4	348.1417	381.5	413.2	454.4
103.5	109.48	115.3	136.5	150.2	173.6
136.7	141.1	144.9	167.9	189.2	220.2
49.8	53.1	52.8	64.3	75.8	88.3
1287.6	1539.6	1966.3	2450.0	3003.1	3710.2
1.07	1.13	1.23	1.34	1.42	1.49
560.2	720.8	954.4	1250.3	1630.2	2112.5
7100	6651	6566	6874	7838	8954
30.7	29.9	23.7	24.1	24.0	24.7
7192	6841	9083	9352	10464	11847
26936	30721	31992	32635	33941	34476
252631	308487	353807	476264	573178	693917
132399	182226	190238	214003	268002	351782
884	1085	1334	1551	1818	2227

Table 1the numerical value of technology advance indicators

3.2 The analysis of technology advance's impact on China's energy consumption per unit GDP

According to the calculation method of gray correlation, we could calculate the correlation degree of each index between technology advance and energy consumption per unit GDP, the calculated results as below Table 1:

X1	X2	X3	X4
0.8273	0.7724	0.8271	0.7793
X5	X6	X7	X8
0.6423	0.7746	0.6085	0.8655
X9	X10	X11	X12
0.9308	0.8527	0.8722	0.6503
X13	X14		
0.6655	0.6595		

Table 2 gray correlation degree

According to the gray advantage theory, we select the indexes whose correlation degree are more than 0.8 (second accuracy level) as the key technology progress indexes. We order the gray correlation degree according to amount, so X9, X11, X8, X10, X1, X3 are regarded as the key technology progress indexes which can effect China's energy consumption per unit GDP.

It has a larger impact of the large and medium-sized industrial R&D enterprises and technology institutions on China's energy consumption per unit GDP reduction, which is the core strength to reduce China's energy consumption per unit GDP. China should give more focus on strengthening their quality. Most of the energy consumption are produced in the large and medium-sized industrial enterprises; R&D enterprises quality in enterprises technology activities directly affects whether the energy enterprises have the capacity to improve the utilization of energy, and also creates a favourable environment for the high energy-efficient production.

The number of technology achievements awards fluctuates, but there is an upward trend in the recent years, which reflects the achievements of technical progress and the achievements directly or indirectly reflect that technology advance can gradually reduce China's energy consumption per unit GDP. The technology activities quality represents a country's technology advance level, but the increased technology activity personnel can not necessarily mean enhanced quality, so China should strengthen the quality of technology activities, and strengthen the efficiency of energy utilization.

We set up multiple linear regressions analysis combining the above six technology indexes and China's energy consumption per unit GDP: [7]

Y=-0.00366X9+4.1*10-6X11+2.17*10-5X8-5.7*10-6X10-0.00094X1+0.000472 X3+0.251124

R Square is 0.989559, namely these six indicators can explain over 98% of the impact of technology advance on China's energy consumption per unit of GDP, which explain the selection for these six technology advances indicators is reasonable.

4 The goal prediction on China's energy consumption per unit GDP

China's 11th Five-Year Plan explicitly brings forward that energy consumption per unit GDP will decline 20% during China's 11th Five-Year Plan period. We use grey prediction model to see whether the goal can be reached Gray series of numbers prediction mainly refers to the prediction on the time series data by using GM (1, 1) model.

According to 1997-2007 data, calculation and test results are shown in following tables. [8]

Model parameters: a=0.044181 ； b=0.177200
$x(t+1)=-3.815585e^{-0.044181t}+4.010785$
Evaluation of the current model: C=0.2048 (GOOD)；p=1.0000 (GOOD)
The future value prediction of three times: X(t+1)=0.10143 ； X(t+2)=0.09705 ； X(t+3)=0.09285 ； Qmin=-0.01190

Table 3 GM (1, 1) prediction results

The analysis results show that China's energy consumption reduction rate per unit GDP in 2010 as follows:

（0.1142-0.09285）/0.1142*100%=18.695%<20%

Therefore, China could primarily achieve the goal of reducing energy consumption per unit GDP 20% at the end of China's 11th Five-Year Plan period, but there are still some gaps. In order to achieve the goal better, we need to put forward some appropriate measures.

5 The suggestions for achieving the goal of China's energy consumption per unit GDP

5.1 Increase in R&D expenditures to transform scientific researches into productivity

Transforming technology into actual productivity is a process with a close combination of technology and economy. In China thousands of scientific and technical payoffs and patents of invention come out each year, many of which are outcomes with broad market prospects. If used in our economic construction, they are considerable wealth. However, so far few of them are transformed into productivity. Lack of R&D expenditures and pilot-plant bases in technology activities R&D enterprises, they can not do a secondary development by pilot studies to make the scientific payoffs up to commercialization level. In general, the commercialization of scientific and technological achievements must go through a pilot test process with perfect technology and mass production, funds for which should be generally higher 10 times than scientific research. Therefore, the establishment of large and medium-sized R&D enterprises pilot bases and a substantial increase in funding for pilot-link input are both necessary. [9~10]

5.2 Funds increase for energy-saving technology research

Increase energy-saving technology investment, reduce energy consumption by using high and new, advanced and applicable technology, establish a mandatory policy on resource conservation technology, compulsively eliminate backward producing technology and technics, support and encourage enterprises to research and develop recycling economy technical system. In local research planning, recycling economy technology is listed as a priority to guide enterprises, universities, research institutes to develop energy-saving technologies. [11]

5.3 High-tech promotion research in the application of energy consumption

Increase government research input in new energy and clean energy and enhance technology content of energy industry, such as new energy technologies, some R&D investments on coal oil, coal gas and other projects. We should greatly develop new energy technology, energy and coal efficient technology. [12]

5.4 Finance increase in energy economy research subject

At the present stage, rapid growth in China's total energy consumption is attributed to lower coal price, resulting in enterprises' waste in the process of energy consumption and more power wastage in unit GD. Therefore, an intensive study on energy pricing mechanism must be done in order to ensure both economy growth and energy conservation.

In addition to the above proposals, it is necessary to strengthen supervision and management mechanism and it is also a must to start full energy consumption in China three major energy consumption sectors: transport, industry and construction.

6 Conclusion

Through the analysis and compare of China's energy consumption per unit GDP and technology advance actuality, this paper considers that China's energy consumption per unit GDP has an unconspicuous downward and lies on a lower consumption level. Although technology advance can increase China's energy consumption level, but can not be given full play to reduce the growth rate of China's energy consumption and energy consumption per unit GDP. The goal of reducing 20% energy consumption per unit GDP at the end of China's 11th Five-Year Plan should be achieved, but there are still some inadequacies. So we provide the corresponding proposals so as to give effective views to some relevant departments.

Acknowledgements

This paper is part of research the results of the National Soft Science Project in China: "The development model and countermeasures research of China's environmental protection industry for two types of society." (2008GXS5D132) and supported by the National Natural Science Foundation of China(70973016):"The study on the regional Environmental Protection Industry competitiveness based on the factor endowments and government regulation".

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