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The impact of technology innovation on green chemistry and low-carbon economy growth

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ABSTRACT

The traditional chemical industry brings the environment pollution has been very serious, hazardous waste are produced worldwide each year up to 3-4 Million tons, this situation only cause harm to the environment, but also threaten the survival of mankind. Technical innovation is an effective solution to this problem,first of all, we construct the endogenous economic growth model to analyze the low-carbon economic growth, from the results we can get that: if the technical innovation has a sufficiently high efficiency, economy can overcome the constraint of non-renewable energy consumption, achieve green chemistry and low-carbon economy growth. Therefore, technological innovation is the fundamental way to solve the problems of environment and resources, and also the essence to develop low-carbon economy. China should better use financial factors to promote the low-carbon economic growth and change the economic growth model.

Keywords*:* Technology Innovation, Green Chemistry, Financial Functions, Low-carbon Economic Growth

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INTRODUCTION

At present, the global warming problem which caused by carbon dioxide emissions is causing a lot of attention from international society. In 2005 the world economic forum put climate change as one of the third big challenges in the world, G8 summit to climate change as one of the most important issues[1]. In 2006, the British government announced the " Stern review " drafted by Nicholas who is the former world bank chief economist, this report make a quantitative analysis to the economic effects of global warming, and point out that the economic costs of climate change is almost same as a world war economic loss. Thus, greenhouse gas emissions is closely related to the level of economic development and the quality of human life[2], global climate change may also have evolved as a disaster which will affect the whole world .

After 1980’s, with the rapid development of Chinese economy, the energy consumption is increasing fast, the total energy consumption grew nearly five times within 30 years in China[3]. Chinese energy consumption mainly includes coal, oil, natural gas and other fossil fuel; coal accounting 71.4% of the total energy consumption, oil accounting for 20%, natural gas accounting for 2.4%, as shown in Figure 1. While the carbon dioxide emissions produced by fossil energy consumption accounted 75% of China total carbon dioxide emissions [4]. China’s carbon dioxide emissions growth rate has been the forefront of the world and growth rapidly in recent years. At present, China’s carbon dioxide emissions produced by fossil energy consumption have been ranked second in the world. It is expected that by 2030, China’s carbon dioxide emissions is likely more than the United States, ranking first in the world [5].

Since the 1960's, the population dimensions and economic gross grows continuously, as the earth's natural resources decreased and the human environment deteriorated, environmental problem get more and more attention. Dasgupta [6] and Heal using CES production function, they considered the non-renewable resources as raw materials and put them into the production function to study the economic growth. Stiglitz[7]considering the population growth factors in the new classical economic growth model. Finance is the core factor of the economy growth, the history of economic development shows that: the role of finance has been growing in the past five hundred years to promote economic development, especially in the highly developed modern economy; finance has played an irreplaceable role. The first scholar who comprehensive studies the relationship between finance and economy growth is Bagehot, he found that the financial system plays a key role by providing large capital during the British industrial revolution. Schumpeter[8]argue that financial intermediary services is has crucial effect to economy growth, bank promoting technical innovation by provide funds to the most competitive entrepreneurs, and finally promote the economic growth. Gurley and Shaw [9] developed the Schumpeter's point of view; they think that financial development is a necessary condition for economic growth. Patrick [10] first put forward the causal relationship between finance and economic growth; he thinks three is a two-way causal relationship between finance and economic growth.

EXPERIMENTAL SECTION

2.1 Low-carbon economy growth model

We analyze a closed economy which has five sectors: the final product sector, human capital sector, R&D sector, intermediate products sector and energy production sector. Economic operating mechanism is that: Human capital sector develop human capital, were used for the final product sector, R&D department and human capital sector; R&D sector use human capital and existing technology to develop new technologies; intermediate products sector use the material capital and technology which provided by R&D departments to product a series of durable intermediate products; energy production departments engaged in product renewable energy ; the final product sector use human capital, intermediate products and renewable energy sources to produce the final product. The final product sector produces the final product and exhaust carbon dioxide emissions at the same time. Economic operation mechanism can be shown as figure 1. According to the meaning of low carbon economy growth, it requires non-renewable energy growth rate was negative, while the carbon dioxide emissions growth rate is also negative. Because we should gradually reduce the non-renewable energy consumption during the production process, otherwise it can not solve the carbon dioxide emissions problem fundamentally, also cannot achieve a low carbon economy growth.

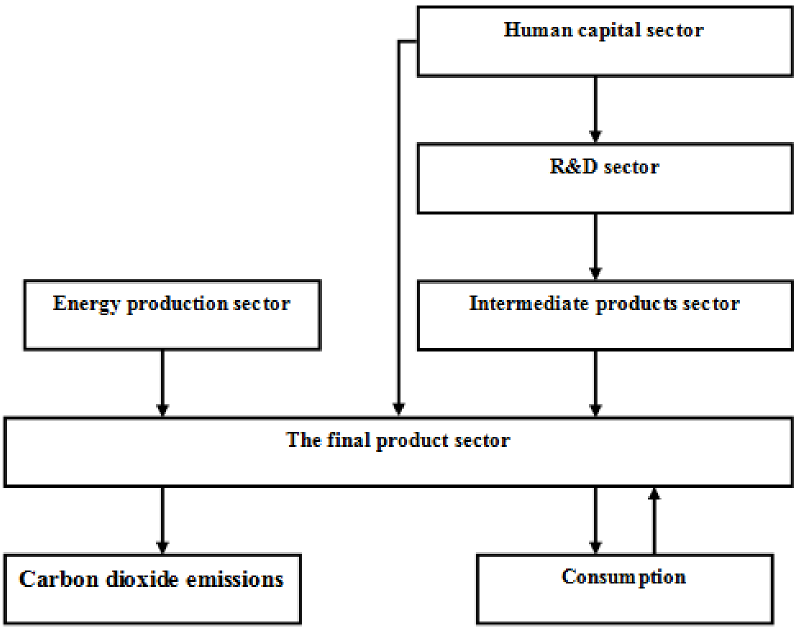

Figure 1. The operating mechanism of the economy

2.2 Various departments' production function

We presume the final product production function D-S function, and introduce the non-renewable energy as a factor into the production function, therefore, the production function of final product sector is:

$$Y = H_r^{a_1} \int_0^A X_i^{a_2} di E^{a_3} \tag{1}$$

In formula 1, 0<a1<1; 0<a2<1; 0<a2<1, and a1 +a2 +a3=l. This means that the production function has constant returns to scale. Hr represent human capital which has been put into final product sector, Y represent per capita output, A is the type number of intermediate products, represent the stock of technical knowledge. We presume A is continuous; Xi is the quantity of intermediate product i; E is non-renewable energy that put into final production department.

Human capital mainly depends on the production efficiency of human capital and input quantity, therefore, the human capital production function:

$$\dot{H} = \delta_H (H - H_r - H_A) \tag{2}$$

Assume that the technology in R&D sector is non-exclusive; so, technology innovation mainly depends on the Department's human capital investment and the existing technical stock. The R&D sector production function:

$$\dot{A} = \delta_A H_A A \tag{3}$$

A represent the technical stock in economy; δA represent possibility of technological innovation, the greater the δA is the higher the possibility of technological innovation; H represent the human capital investment. In the intermediate products sector, once the new varieties of products or design was invented by the R&D department, one unit of the intermediate product Xi (i⊆[0,A]) just consumed 1 units of material capital K, therefore, the capital amount can be expressed as:

$$K = \int_0^A X_i di \tag{4}$$

According to the final product sector production function, the entire intermediate product Xi is asymmetrical, and the input requirement is same. For ∀i∈[0,A],we can get Xi= X=K⁄A. Put this into the final product production function, we can get:

$$Y = H_Y^{a_1} A x^{a_2} E^{a_3} = H_Y^{a_1} A^{1-a_2} K^{a_2} E^{a_3} \tag{5}$$

We presume there is no capital depreciation, therefore, the increase of capital stock value equals to the total output subtracts consumption, and thus the material capital accumulation equation is:

$$\dot{K} = Y - C \tag{6}$$

We assume S is the stock of non-renewable; E is energy into flow the final product production process. We assume existing energy are non-renewable, the initial stock of energy is S0, and then the stock of energy is:

$$S = S_0 - \int_0^1 E(v) dv \tag{7}$$

Based on the derivation of time t, we can get consumption changes of non-renewable energy:

$$\dot{S} = -E \tag{8}$$

Assumed representative consumer has a standard fixed elastic utility function in the infinite domain;

$$U(C) = \int_0^\infty \frac{c^{1-\sigma} - 1}{1-\sigma} L e^{-\alpha} d_1 = \int_0^\infty \frac{c^{1-\sigma} - 1}{1-\sigma} e^{-\alpha} di \tag{9}$$

The c=C / L represent per capita consumption, L represent the total population, as we assume the total population is 1, thus, the per capita consumption are equal to total consumption. σ is marginal utility elasticity,ρ is the consumer's time preference. According to input and output of the final product department, human capital development of human capital department, technology research and development of the R&D department, production of product department and non-renewable energy consumption, Social dynamic optimization mathematical expression can be shown as:

$$\max U(C) = \max \int_0^{\infty} \frac{C^{1-\sigma} - 1}{1-\sigma} e^{-\alpha} d_i \tag{10}$$

We use Hamilton function to calculate the value of this dynamic optimization model, the equation is:

$$\begin{aligned} H_C &= \frac{C^{1-\sigma} - 1}{1-\sigma} + \lambda_1 \left[H_r^{a_1} A^{1-a_2} K^{a_2} E^{a_3} - C \right] + \lambda_2 \left[\delta_H (H - H_r - H_A) \right] \\ &= + \lambda_3 (\delta_A H_A A) + \lambda_4 (-E) \end{aligned} \tag{11}$$

On the balanced growth path, each variable growth rates were constant. According to relationship of consumption, investment and output, we can known that the economic variables Y, C, K have the same growth rate, and g_r, g_c, g_x are the same constant. According to the above formula, then the only transversality condition is:

$$(1-\sigma) g_r - \rho < 0 \tag{12}$$

According to the substance of low carbon economy growth, the necessary condition to achieve a low carbon economy growth is: $g_r>0$, $g_E<0$, it means the per capita output increases ceaselessly, the consumption of non-renewable energy sources ceaselessly reduce. To achieve this conditions need δ_H,δ_A sufficiently large; ρ sufficiently small and $\sigma \geq 1$. Therefore, once the economy has enough human capital accumulation efficiency and technical efficiency, it will resulting in higher efficiency of technological innovation and can reduced consumption of non-renewable energy sources, achieve the low-carbon economy growth.

2.3 Empirical Results

We make the empirical test of the relationship between the financial factors and the energy consumption. I use the annual data of Loans of financial institutions (DK); the dimension is billion yuan RMB. I chose total energy consumption in chemical industry(E) as energy variable, sample data from the years 1990-2012, data from 2013 “China Statistical Yearbook” and “new China fifty-five years of statistic information.” In order to solve the nonlinear problem, I take natural logarithms of DK and E, as InDK and lnE. In this paper, I ues the ADF unit root test method to test the smoothness of each variable; the result is shown as table 1.

Table 1. The ADF unit root test results of InDK and lnE

variables	LnDK	LnE	d.lnGDp	d.LnE
ADF Test Statistic	-1.7714	0.6275	-4.9746	-2.9583
Inspection type(c,t,k)	(c,0,0)	(c,0,0)	(c,0,1)	(c,0,1)
10% Critical Value	-2.6299	-2.6251	-2.6299	-2.6326
Stationary or not	NO	NO	YES	YES

In order to study the cointegration relation between lnDK and lnE, I made a Johansen Cointegration Test, the result stated in table 2.According to the results from table 2, we can get that InDK and lnE has a strong co integration relationship at 5% significance level.

Table 2. The co-integration test between lnDK and lnE

eigenvalue	Trace test	5% Critical Value	Hypothesized No of CE(s)
0.3115	0.3912	19.6344	None*
0.2629	0.0075	8.8097	At most 1*

According to the test results from table 2, I get the normalized co-integrating equations for LnE in China:

LnE=7.5997+0.4352LnDK+μ
t= (52.6833) (28.1916)

The cointegration relation between lnDK and lnE is positive, that means financial factors will cause energy consumption and carbon dioxide emissions. In order to validate the causal relationship between financial institution loans growth rate and energy consumption growth rates, I used the Grainger causality test as shown in table 3. The result demonstrates that, financial institution loans growth rate is the Grainger reason to energy consumption growth rate, while energy consumption growth rate is not the Grainger reason to financial institution loans growth rate. It means that financial factors have promoted economic growth, but also promote the energy consumption and carbon dioxide emissions.

Table 3. GRANGER causality test results

H0 Hypothesis	Lag	F-statistic	P value	Receive H0 or not
ΔLnE does not Granger Cause ΔLnDK	2	0.1287	0.8799	YES
ΔLnDK does not Granger Cause ΔLnE	2	5.8616	0.0846	NO
ΔLnE does not Granger Cause ΔLnDK	3	0.0769	0.9718	YES
ΔLnDK does not Granger Cause ΔLnE	3	2.4380	0.0929	NO

CONCLUSION

This paper focuses on the mechanism that how financial factors promote green chemistry and the low carbon economy growth. First of all, by using the endogenous economic growth model to analyze the low-carbon economic growth, from the results we can get that: if the technical innovation has a sufficiently high efficiency, economy can overcome the constraint of non-renewable energy consumption, achieve low-carbon economy growth. There need to explain that through the analysis of the model we can get that technology innovation can promote low-carbon economic growth, and the low-carbon economy growth is a necessary condition to the low carbon economy development. Therefore, technological innovation is the fundamental way to solve the problems of environment and resources, and also the essence to develop low-carbon economy. China should better use financial factors to promote the low-carbon economic growth and change the economic growth model.

REFERENCES

[1]Z Gang, *International finance research*, **2010**,10,78-84
[2]P Shui-jun;B Qun,*Quantity economic and technical economic research*, **2006**,3,69-77
[3]Z Si-hai, *Development Research*, **2011**,2,105-110
[4]W Ying, *the world economy and politics*, **2012**,8,11-16
[5]S De-Yong, *Journal of Huazhong University of Science and Technology*, **2011**,9,20-24,
[6] P Dasgupta; Q Heal,Economic Theory and Exhaustible Resources, Cambridge University Press, 1979,79-88
[7] J Stiglitz, *Review of Economic Studies*, **1974**,2,101-112
[8]AS Joseph,The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle, Harvard University Press, 1934,23-28
[9] JG Gurley;ES Shaw, *American Economic Review*, **1955**,45-47
[10]C Yang-yun, *Journal of Regional Financial Research*, **2011**,5,157-162