

Research Article

Research on the Influence of Carbon Tax on Carbon Emission and Economic Development in China

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Abstract: Carbon tax is one of ways to cut the emissions of GHG, which has already been employed by the west. To study the effect of carbon tax on energy conservation and carbon reduction in China, a new model is constructed based on dynamic CGE model and the linkage of dynamic CGE model and energy technology model. Besides the improvement of technology of energy, if carbon taxation is employed, the goal to reduce its carbon intensity by 40% by 2020 compared with 2005 need to levy a tax of 60 yuan at least per tonne, the simulations of this tax to carbon reduction, economic and income of residents are analysed under different circumstances, the results shows that there is a great impact on income of residents and GDP with a higher tax burden level.

Keywords: Carbon intensity, carbon taxation, tax rate

INTRODUCTION

It is a crucial time to develop economic in China, the demand of energy keep rising, before the Copenhagen Climate Change Confenerce 2009, China State Council declared its goal to reduce its unit GDP CO₂ emission by 40-45% by 2020, compared with 2005. In 2005, the total discharge of CO₂ was 5.59 billion tonnes, GDP was 18308.5 billion yuan, the emission of CO₂ of 10000yuan GDP and emitted by fossil fuel were 3.053 tonnes and 2.764 tonnes. According to the forecast of EIA, Wei Y.M (2008), the GDP in 2020 will reach 65845.7, 57288.4, 49745.3 billion yuan (Based on the price of 2005) under the growth of economic of high, middle, low (Table 1).

From Table 2, if the emission intensity of carbon remain unchanged until 2020, the emission of CO₂ by combustion of fossil fuel are 18.26, 15.95, 13.79 billion tonnes under three situations. To achieve the goal of reducing 40%-45%, the amount of reduction of emission are 7.28-8.19, 6.38-7.18, 5.49-6.18 billion tonnes separately.

If the energy technology can reach or approach advanced international standards, a great change will happens in structrue of energy, then 72%~81% of the goal of reducing 40%, 64%~72% of the goal of reducing 45% would be achieved, moreover, other measures to energy conservation and emission reduction need to be taken, such as Zhang (1998) and Zhengshun *et al.* (2012) etc. Carbon taxation is a cost-effective measure which fully uses the market mechanism, absorbs more and more attentions from economists and

Table 1: The growth rate of economic under three situations of economic development (%)

The growth rate of economic	Situation	2010	2010~2015	2016~2020
The growth rate of GDP every year	High	8	9	8
	Medium	8	7.5	6.5
	Low	8	6	5

Table 2: The amount of emission and reduction in three situations (a hundred million tonnes)

Goal of emission intensity of carbon	The total discharge of emission			The amount of reduction		
	High	Middle	Low	High	Middle	Low
In 2005	50.6	50.6	50.6	--	--	--
Remain unchanged	182.6	159.5	137.9	--	--	--
Lower 40% in 2020	109.8	95.7	83	72.8	63.8	54.9
Lower 45%	100.7	87.7	76.1	81.9	71.8	61.8

international organizations, in fact, carbon taxation has been introduced in 20 century 90 years in western countries at first, it also becomes the focus of attention by scholars at home and abroad recently, such as Su (2009a, b), Fisher-Vanden and Ho-Mun (2007) and Liang *et al.* (2007). To understand the relation between carbon tax, energy usage and economic development, a new model on dynamic CGE model and the linkage of dynamic CGE model and energy technology model is constructed, through the data analysis, the effect of reduction of carbon, GDP and income of the residents under different tax rate are studied.

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MODEL DESCRIPTION AND DATA SOURCES

The basic structure of the energy- environment-economic model is on the basis of model of Lofgren *et al.* (2002), added energy and made it dynamic in the plate of technology of production., energy embedded in the model as: substitution between energy firstly, then energy substitute for capital, lastly energy substitute for labor, the relation of substitution are described by the function of constant elasticity of substitution.

The basic data of the model are the social accounting matrix table in 2007 established through data of input-output table in 2007 and corresponding customs, tax revenue, international payments and flow of funds in 2007.

There are 39 industries, 2 groups of household (including urban and rural), 3 factors of production (labor, capital and energy) are set in the model.

The benchmark circumstance are set as; the growth rate of GDP in 2007~2009 is the real value, 8% in 2010, the annual average 7.5% between 2011~2015 and the annual average 6.5% between 2016~2020.

RESULTS AND DISCUSSION

In this study, the carbon tax is aimed at emission of CO₂, the time of carrying out is 2013 and carbon tax is imposed both in industries of using the fossil fuel and the industries of producing the fossil fuel. According to international experience of carbon tax, considering different tax rate of carbon tax and different usage of income of carbon tax, six scenarios are designed as Table 3.

- **The results of simulation of different tax rate and the income of tax belongs to government totally:**
 - **The result of reduction of emission under different tax rates:** With the increase of tax rate, the more obvious of the reduction of emissions. If the income of tax belongs to government totally, the emission of CO₂ are 10.8, 10.24, 9.75 billion tonnes separately under three situations, comparing the benchmark, the amount of reduction are 0.64, 1.2, 1.69 billion tonnes, the rate of reduction are 5.6, 10.5,14.7%, respectively (Fig. 1).

From the simulation of three different tax rates, on the basis of development of low carbon technology and structural transition of energy, when the tax rate is 60 yuan/tonne, it probably promises to achieve the goal of carbon intensity of emission in 2020.

- **The effect on growth of economic under different tax rates:** In general, carbon taxation has little effect on GDP, from Fig. 2, in the beginning of the period; it has the greatest influence, but becomes less and less with time.

Table 3: Design of six scenarios of carbon tax

Scenarios	Tax rate (yuan/tonne)	Usage of income of carbon tax
s1a	30	belongs to the government totally
s2a	60	belongs to the government totally
s3a	90	belongs to the government totally
s2b	60	government owns half, key industries own another
s2c	60	government owns half, residents own another
s2d	60	key industries own half, residents own another

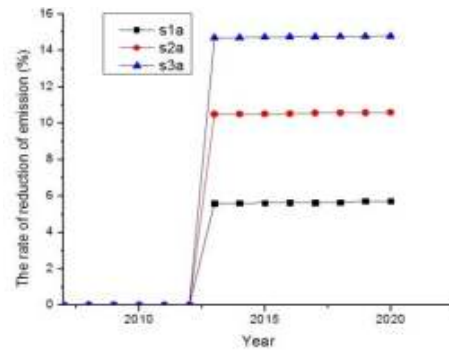


Fig. 1: The rate of reduction of CO₂ under different tax rate

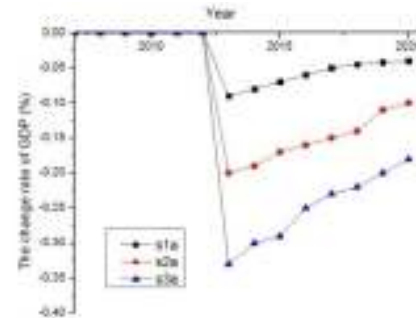


Fig. 2: The change rate of GDP under different tax rate

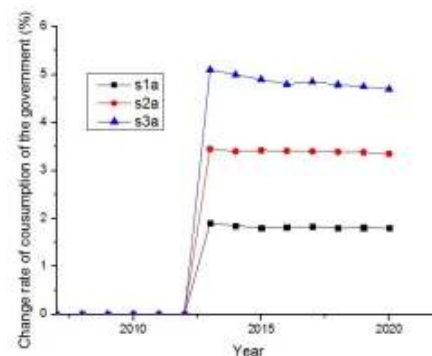


Fig. 3: The change rate of consumption of the government under different tax rate

Compared with the benchmark, under high, medium and low tax rate, the loss rate of GDP would be 0.09%, 0.2% and 0.33% in 2013, 0.04%, 0.1% and 0.18% in 2020 separately (Fig. 2); the consumption of

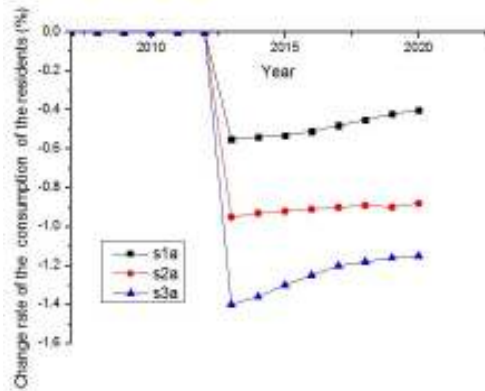


Fig. 4: The change rate of consumption of residents under different tax rate

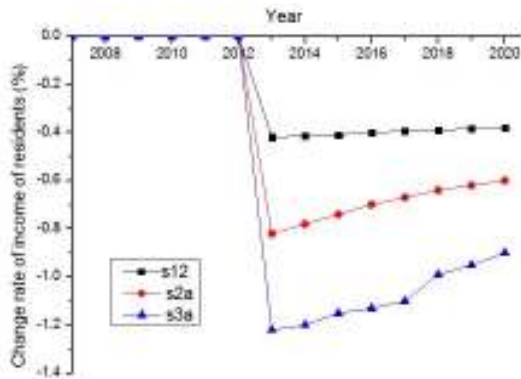


Fig. 5: The change rate of income of residents under different tax rate

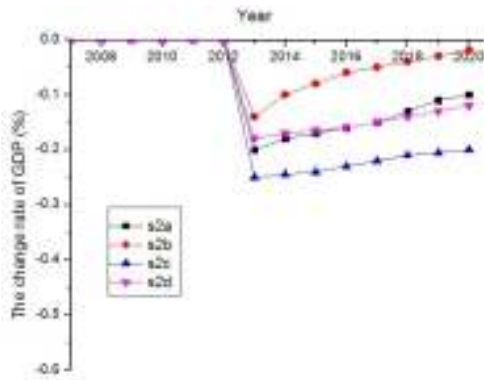


Fig. 6: The change rate of GDP under different usages of income of carbon tax

the government will increase 1.86%, 3.53% and 5.02% in 2013, 1.85%, 3.49% and 4.97% in 2020 (Fig. 3); carbon tax put a burden on residents, so the consumption of resident decrease, the ratio of reduction would be 0.49%, 0.95% and 1.39% in 2013, 0.38%, 0.74% and 1.07% in 2020 (Fig. 4). It has a relative great negative influence on the resident's income, from Fig. 5, in the beginning of the period, it has the greatest influence, but becomes less and less with time,

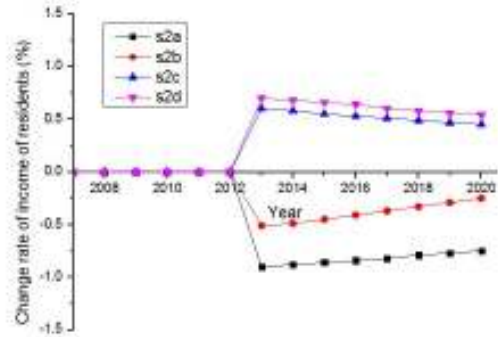


Fig. 7: The change rate of income of residents under different usages of income of carbon tax

the falling ratio of income would be 0.45%, 0.83% and 1.42% in 2013, 0.39%, 0.65% and 0.95% in 2020.

- **The results of simulation of different usage of income of carbon tax**
 - **The result of reduction of emission under different usages of income of carbon tax:** There are four different usages of income of carbon tax established as s2a, s2b, s2c, s2d (Table 3), the simulation shows that the amount of reduction of emission are 1.20, 1.04, 1.2 and 1.04 billion tonnes separately in these four situations, the rate of reduction are 10.45, 9.12, 10.5 and 9.12% in these four situations, the rate of energy conservation are 7.5, 6.33, 7.52 and 6.3% in 2020, respectively. From the results, the situation s2b and s2d effect the reduction in some degree.
 - **The effect on growth of economic under different usage of income of carbon tax:** In general, different usages of carbon taxation has little effect on GDP. In the beginning, it has the greatest influence, but becomes less and less with time. Compared with the benchmark, the loss rate of GDP would be 0.14%, 0.02% in 2013 and 2020 in situation s2b, 0.25% and 0.2% in 2013 and 2020 in situation s2c (Fig. 6). Considering the tax, when government owns half, key industries own another, it has little negative effect to the GDP, in s2a and s2b, it has great negative influence on the income of the resident, but in s2c and s2d, the income will increase in some degree (Fig. 7).

CONCLUSION

Carbon tax is one the most important method to achieve the goal of carbon reduction, to understand the influence of reduction of emission and economic development under different carbon taxation and different usages of income of carbon tax, a energy-environment-economic model based on dynamic CGE model is constructed, 6 different situations are developed, when the tax rate is 60 yuan/tonne, it

probably promises to achieve the goal of carbon intensity of emission in 2020. Considering different usages of income of carbon tax, four scenarios are set, through the simulation, carbon tax has little influence on GDP, and resident's incomes have change with different situations. But it brings heavy pressure and burdens to industries of energy, when putting into practice, it may encounter great resistance and difficulties which hard to implement.

ACKNOWLEDGMENT

This study was supported by the Special Fund for Basic Scientific Research of Central Colleges, South-Central University for Nation-alities, CZQ12016.

REFERENCES

- Fisher-Vanden, K. and S. Ho-Mun, 2007. How do market reforms affect China's responsiveness to environmental policy? *J. Develop. Econ.*, 82(1): 200-233.
- Liang, Q.M., Y. Fan and Y.M. Wei, 2007. Carbon taxation policy in China: how to protect energy and trade-intensive sectors? *J. Policy Model.*, 29(2): 311-333.
- Lofgren, H., R.L. Harris and S. Robinson, 2012. A Standard Computable General Equilibrium (CGE) Model in GAMS. Retrieved from: <http://www.ifpri.org>, (Assessed on: December 20, 2012)
- Su, M., Z.H. Fu, *et al.*, 2009a. The international experience and reference from carbon tax. *Environ. Econ.*, 9: 28-32.
- Su, M., Z.H. Fu, *et al.* 2009b. The forecast of effect and assessment the effectiveness of carbon tax in China. *Environ. Econ.*, 9: 23-27.
- Zhang, Z.X., 1998. Macroeconomic effects of CO₂ emission limits: A computable general equilibrium analysis for China. *J. Policy Model.*, 20(2): 213-250.
- Zhengshun, R., L. Aihua and Y. Hong, 2012. The multi-objective programming model of the structure of energy consumption on China. *Res. J. Appl. Sci. Eng. Technol.*, 4(21): 4488-4491.