Development of a Shanghai CGE model and the application on forecasting the power demand in Shanghai

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1. Introduction

The development and application of CGE model become more and more popular in economic studies, and become a useful tool for policy making in China. The CGE models developed by Chinese scholars are based on ORANI model (static) and MONASH model (dynamic) developed by COPS (Policy Research Center) of Australia's Monash University. The single regional CGE model in China mainly include the SICGE model developed by State Information Center, DRC-CGE model developed by development Research Center of the State Council, the PRCGEM model developed by CASS and the MCHUGE model developed by Hunan University. Other scholars also develop their own CGE model(Zhou Chifei, Gao Feng, Feng Shan, Li Xuesong).

The Multi-regional CGE models in China mainly include the SICGER model developed by State Information Center, the Multi-regional DRCCGE model developed by development Research Center of the State Council, Multi-regional CGE model with 30 provinces developed by Shi Minjun of Chinese Academy of Sciences, the multi-regional CGE model developed by Wang Fei of University of International Business, the multi-regional CGE model developed by Fan Xiaojing of Shanghai University of Finance and Economics.

As we reviewed, there are many national wide CGE models and Multi-regional CGE model developed by Universities, academic institutes or think tanks. However, the development of specific province CGE models is relatively slow.

In terms of the modeling framework, specific province CGE models is similar to a national model, but need to consider the international trade and domestic trade.

In this study, we developed a Shanghai Electric CGE model to forecast the electricity demand and evaluate the impact of ETS in Shanghai.

2. Model

2.1 General presentation

Developed by the State Information Center (SIC) of China, the Shanghai Electric CGE model (SECGE-SIC) model is used by the Shanghai government as an auxiliary tool for the preparation of public policies. Based on Shanghai's 2007 input-output table, SECGE-SIC includes 128 sectors, 3 categories of production factors (labor, capital and land), 5 labour types, 8 kinds of margins as well as parameters of technology change, consumption preference and market distortion, etc(Zhang and Li, 2010). We also introduced substitution between energy and capital, and the substitution between coal product and oil/gas products in SECGE-SIC. The core and dynamic modules of (Zhang,C.L., ed al. 2011)are based respectively on the ORANI model (Dixon et al., 1982) and the Monash model (Dixon,P.B and Rimmer, 2002).

2.2 carbon tax and ETS module

Firstly, we incorporate the carbon tax into the ad valorem tax, second, We add the ETS module according the method of GTAP-E.

2.3 Recursive dynamic

The dynamic impact analysis is obtained in the recursive form with the SICGE model. Herein, for each sector, the capital stocks at the beginning of year t+1 are equal to the capital stocks at the end of year t, and are the sum of the capital stocks at the beginning of year t and the total investment in year t minus the depreciations in year t. Based on such setting, the policy shock in year t will have no impact on the capital stocks at the beginning of year t,, but will change the industrial expected rate of return, which in turn could affect the industrial investment in year t andthe capital stocks at the beginning of year t+1.

During calculating the dynamic impact of policy shock, in SICGE, the special sticky mechanism is used for the change of labor and real wage relative to the value in base case (including historical and forecasting value), following the work of P.B.Dixon and M.T. Rimmer(2002). In most CGE applications, it is assumed that employment is fixed and labor market clear is reached through the change of real wage. This can be seen as the long-run mechanism. For other applications, it is assumed that wages are unaffected by the policy shock. This entails involuntary unemployment, which can be seen as the short-run mechanism. Here we take a compromised way, with wages are sticky in the short run and flexible in the long run.

3. Data

3.1. Sector classification and economic data

This paper adopts 2007 data and uses 2007 as base year. However, the most detailed publicly available data of sectoral energy consumption by fossil fuel types provided by Shanghai's Energy Statistical Yearbook (ESY) is aggregated at 44-sector level. For both reasons of simplicity and data availability, we regrouped the sectors in the SECGE-SIC into 128 corresponding sectors. Detailed explanation of the division of sectors.

3.2. Sectoral fossil fuel consumption

Fossil fuel consumption per sector in 2007 was obtained based on Shanghai 2008 ESY. The carbon contents and combustion rates of fossil fuels were obtained respectively from the IPCC (2006) and Ou et al. (2009). It must be noted that the CO2 emissions produced by industrial processes are excluded due to data unavailability. This could significantly reduce the impact of the carbon cost on sectors with high process CO2 emissions, for example, the cement sector. Further studies may include such process emissions, particularly, based on the industrial process CO2 emission inventory, which is soon due for completion.

4. Scenarios settings

S1). Only shock Carbon Taxation: RMB 20/tonne CO2, and we assume total carbon cost could pass through of electricity sector, so that the electricity price will not be regulated, and hence fluctuated following the carbon pricing.

S2). Only shock Carbon Taxation: RMB 40/tonne CO2, and we assume total carbon cost could pass through of electricity sector, so that the electricity price will not be regulated, and hence fluctuated following the carbon pricing.

S3). Only shock Carbon Taxation: RMB 100/tonne CO2, and we assume total carbon cost could pass through of electricity sector, so that the electricity price will not be regulated, and hence fluctuated following the carbon pricing.

Table 1 Three scenarios settings

Scenario	***Controlling Indicators***
S1	*Carbon Taxation: RMB 20/tonne CO2*

S2	*Carbon Taxation: RMB 40/tonne CO2*
S3	*Carbon Taxation: RMB 100/tonne CO2*

5. Results

In order to prevent repeating, we interpret in a detailed manner the short-term impact of S3 which is representative enough for understanding the impact of carbon tax in Shanghai..

5.1CO2 emission reduction and carbon tax

According to figure 1,the CO_2 emission reduction rate is 11.6% under 100yuan/tCO_2 under S3.

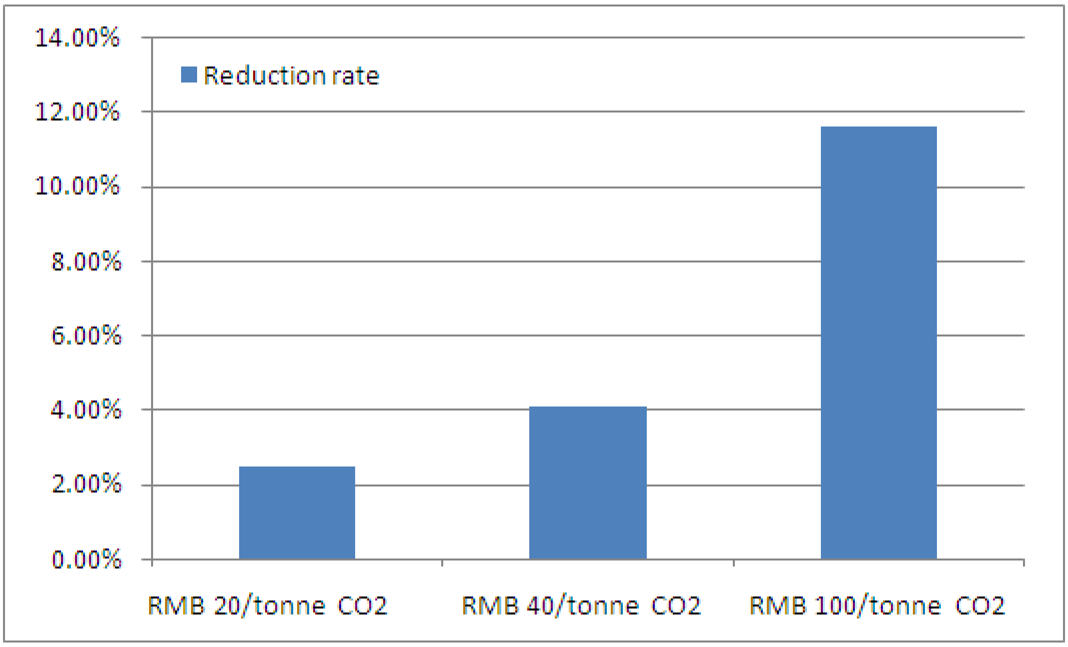

Figure 1 CO2 emission reduction and carbon tax

5.2 Macro economic impact

The short-term macro economic impacts of carbon tax under three scenarios are shown in Figure 2, following the short-term assumption, real wage, capital stock and technology parameters are all almost stable. As seen, under 100 yuan/ton CO_2, the negative macro economic impacts are as follows: relative to the baseline level, the GDP is reduced by 3.89%.

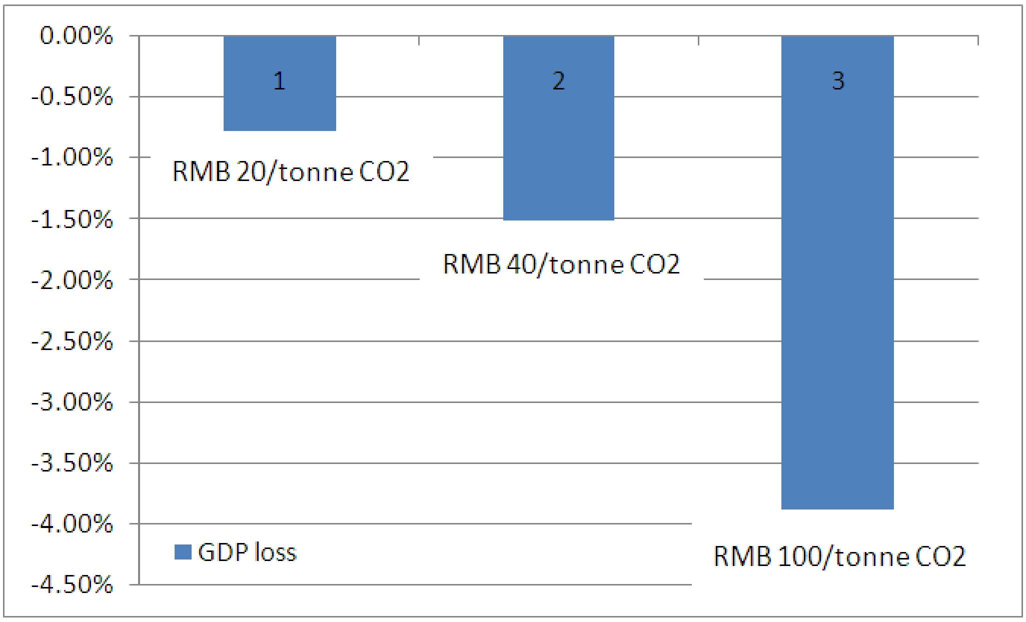

Figure 2 GDP loss and carbon tax

5.3 Effect on the output of electricity

According to figure 3, the output of all industries decreased under 100yuan/tCO2. Particularly and not surprisingly, the output of the electricity sectors is drastically cut. The output of electricity reduced relative to base scenario by 15.82%, this mainly because of the substitution effects, we have the mechanism allowing the substitution between domestic electricity and electricity from other provinces.

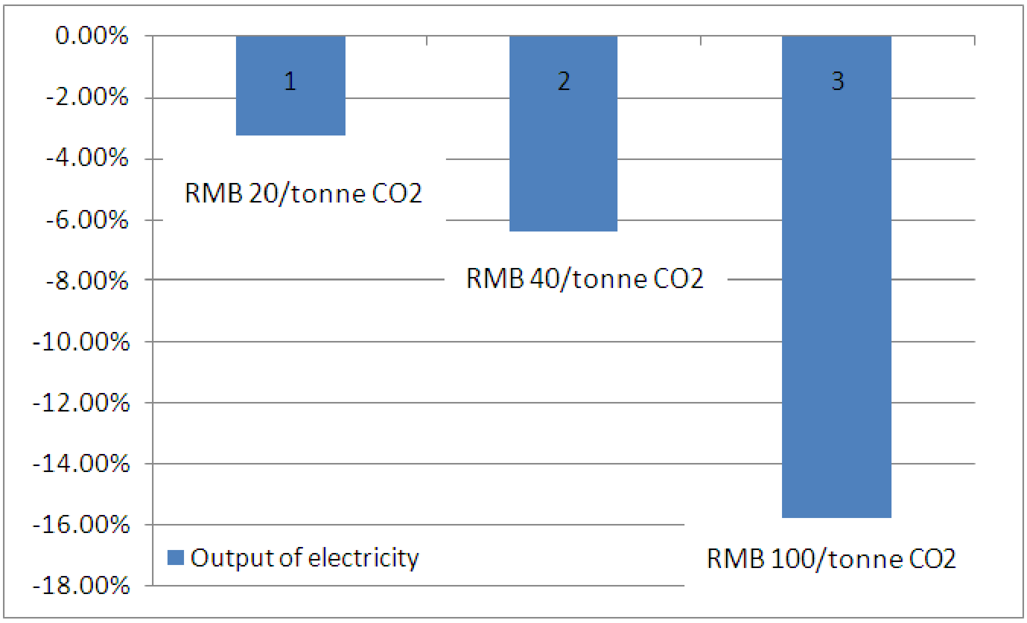

Figure 2 The output of electricity and carbon tax

6. Conclusion

The model has shown that electricity sector would be the major contributor to CO2 emissions reduction under carbon pricing policy. Ferrous metal, basic chemical, coal mining as well as some other energy-intensive sectors are also major contributors of CO2 emissions reduction following electricity sector. This result corresponds to the higher share of carbon cost to sectoral value-added of these sectors that the linear static analysis shows. Further, the relatively limited numbers of principal contributing sectors of CO2 emissions reduction could provide a solid reference when deciding the coverage issue of carbon pricing policies whether in the form of an emission trading system or a carbon tax. Instead of implementing national wide carbon pricing policy, the carbon cost could be assigned to a limited number of energy-intensive sectors and could achieve more or less the same emission reduction target while requesting less implementation and management costs.

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