

The Impacts of Carbon Tax on Sectoral Competitiveness in China¹

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Abstract

China is expected to implement carbon tax in the near future to limit emissions of greenhouse gases. Despite the theoretical efficiency advantages of carbon taxes, concerns of reduced international competitiveness are often an obstacle to their implementation. This paper assesses the competitiveness impact of carbon taxes using simulations based on dynamic computable general equilibrium model for China's economy. Our simulation results show there is likely stronger negative impacts on international competitiveness, which are reflected in declining exports, increasing imports, as well as raise the consumer price index, when unilateral environmentally policy instruments are implemented.

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Introduction

Now China's economy is confronting with twin challenging problems of energy supply security and environmental pollution. To maintain rapid economic growth in order to provide enough employment to assure political stability is of the highest priority, Chinese government are turning China's economic growth to the low-carbon direction. Chinese policy makers believes that energy-efficiency measures, as well as the government's push for implementing carbon taxes and setting up CO₂ emissions market to limit carbon emissions, are putting the nation on a long-term path to low-carbon economy.

Carbon taxes have been advocated as a cost-effective instrument for reducing emissions. From an economic point of view, a carbon tax levied on fossil fuels based on their carbon contents could give clear price signals on carbon cost (Stern, 2009). Direct regulation of polluting activities, forces immediate compliance regardless of the comparative cost for different businesses and individuals, and can be more difficult and costly for some than for others. One of the most important considerations with regard to environmental policy is whether it is damaging to the economic competitiveness of firms or nations. While using taxes to achieve environmental objectives is clearly efficient for the economy as a whole, however, in practice individual businesses or sectors may resist because they will be "losers" in the equation. Governments need to address such concerns about the negative impacts of environmental taxes on sectoral competitiveness such as energy-intensive or export-oriented industries, and on income distribution if environmentally related taxes are to be a useful tool.

Based on a dynamic computable general equilibrium model for China's economy, this paper investigates the impacts of implementing carbon tax on CO₂ emissions from the combustion of fossil energy and from cement production process on export-intensive competitiveness, as well as the macroeconomic variables. The main finding is, as for a low carbon tax, such as 10RMB per ton CO₂ emission, there is no significant competitiveness impact on export-intensive industries selected and also the emissions abatement are also relatively small; as for a high carbon price, such as 100RMB per ton

CO₂ emission, there is relatively large impacts on those sector selected, and also impacts on macroeconomic variables are considerable. Therefore certain compensatory measures are necessary to keep the negative impacts to an acceptable level. Our contribution is the development of an elaborated dynamic CGE model and some of the elasticity values are empirically obtained from our own studies.

This paper is structured as follows. A selected literature survey is presented in Section 2. Section 3 discusses the CGE model and the data set used here. Section 4 explains the main simulation results. Finally, Section 5 concludes with policy implications from these case studies.

Previous literature

The impacts of environmental regulation or carbon taxes on sectoral competitiveness have been investigated in a number of studies, although most of them are qualitatively discussed. Based on the experiences of implementing environmentally related taxes at some OECD countries, OECD (2001) conclude that one of the main obstacles to implementing environmentally related taxation is the possible loss of international competitiveness of some economic sectors and exemptions and rebates are offered and/or taxation revenues recycled to industry precisely to avoid the reduction in competitiveness of some sectors. Wang et al. (2011) divided China's economy into 36 sectors, based on its 2007 input-output table, provided a detailed analysis of short-term impacts of carbon tax on sectoral competitiveness. They divided the sectoral trade impact into domestic competitiveness with regards to foreign imported products and international competitiveness external to the Chinese domestic market. They found that a high tax level (100yuan/tCO₂) may necessitate compensatory measures to certain highly affected

industries, and that a low tax rate (10yuan/tCO₂) would generate few competitiveness problems for all industries and may therefore be considered as an appropriate starting point. Lu (2010) argues that it is still too early for China to impose carbon tax because the introduction of carbon tax in near future will have huge impacts on energy sector and the whole economy. Wang (2009) argue that carbon tax will be an effective policy instrument for China to actively react to climate change and promote energy saving and emissions reduction. Using a computable general equilibrium model, they simulate the impacts of carbon tax on Chinese economy, especially on energy saving and carbon emissions reduction. They show that a low-rate carbon tax is a feasible choice. The impact of low-rate tax will not have big impact on Chinese economy, but will significantly stimulate carbon emissions reduction. Also with general equilibrium model, Wei and Glomsrød(2002) computed the energy consumption in production sectors and residential sector, covering 19 commercial energy products, including coal, oil and natural gas. They conclude that carbon tax will slow down economic growth and largely reduce carbon emissions. For the scenario with tax rate of US\$5 per ton of carbon, the short-run impacts are that GDP will fall by about 0.4% and carbon emissions will fall by 8%; the long-run impacts are that GDP will fall by 0.1% and carbon emissions will fall by 0.4%. For the scenario with tax rate of US\$10 per ton of carbon, the short-run impacts are that GDP will fall by about 0.85% and carbon emissions will fall by 14%; the long-run impacts are that GDP will fall by 0.07% and carbon emissions will fall by 4%.

From the literature survey, we believe the conclusion from modeling literature above is that unilateral carbon taxes are likely to cause some reductions in the competitiveness of

export-intensive sectors of China's economy. And there is no consensus on to what extent the impacts would be and what kind of measures are feasible for China's economy.

Methodology

The method adopt here is to investigate the effects of carbon policy on macro economy and industrial competitiveness, which is defined as the relevant variable deviation between the case with carbon policy and the baseline scenario if historical trends prevail, by CGE simulations.

The model is a single-region, Monash-style dynamic CGE model of the Chinese economy, including 138 sectors. In particularly energy-intensive sectors and trade-intensive sectors are described in detail. There are six modules: household, production, trade, government, emissions, and factor markets. Our model incorporates two types of inter-temporal links: physical capital accumulation and lagged adjustment in the labor market.

This model estimates changes in tastes and technology and generates up-to-date input-output tables via historical simulations, generates baseline forecasts for industrial, occupational variables using detailed extrapolations of trends in tastes and technology together with a wide variety of projections from organizations specializing in macro, population and policy forecasting via forecast simulations, and calculates the deviations from explicit forecast paths for macro-economy and competitiveness-related variables which would be caused by the implementation of carbon policy via policy simulations.

As for the production module, the cost of inputs satisfy the minimizing principle, the

inputs of the industry production include the basic production primary factors (labor, capital and land) and intermediate inputs. Most of the production functions are CES function and contain constant elasticity of substitution between many inputs in the CES function. In order to reflect and handle the inputs substitution between the energy sources and primary factors, our model built up the nesting of CES aggregator functions. Some elasticities of substitution we referenced is Kemfert and Welsh (2000), we also adjust some of them according to actual history data. In our model, the elasticity of substitution between fossil energy is 1.5, the elasticity of substitution between primary factors is 0.7, the elasticity of substitution between fossil energy commodities and electricity is 0.9, the elasticity of substitution between energy commodities and primary factors is 0.6. Output commodities are used for domestic demand and export, the revenue of enterprise meet the maximizing principle, also we assume that the relationship between domestic and export commodities satisfy the Constant Elasticity Transformation function (CET).

Demand module consists of five parts which include investment demand, consumer demand, export demand, government spending needs and inventory demands. Investment demand depends on the expected rate of return; Household income derived from the GNP, The private households are assumed to maximize a Klein-Rubin utility function in their respective budget constraints, which obtained from the optimal conditions of utility function is a linear expenditure System (LES). In the export demand module, the export demand is assumed to describe by downward-sloping curve with the constant price elasticity. Government spending and inventory demand are based on the constant expenditure shares of total expenditure. Distribution cost is the product cost from the

factory (or import) flows to different users, such as transportation, services. The different flow of Products includes the intermediate products inputs, investment goods, household consumption, exports and government spending. In trade module, the function between the imports and domestic commodities are assumed to meet the condition of Armitington, which recognize the difference and incomplete substitution between the domestic products and imports commodities. The average world price of imports commodities exogenous, the production activities in the price module is assumed to meet the conditions of net zero profit.

The Carbon Emission Module not only considers the carbon emissions of fossil energy, but also considers the process emissions of the cement. We impose carbon tax on fuel combustion emissions (coal, natural gas, refined oil) in the form of consumption tax, but we impose carbon tax on the process emissions of the cement in the form of production tax.

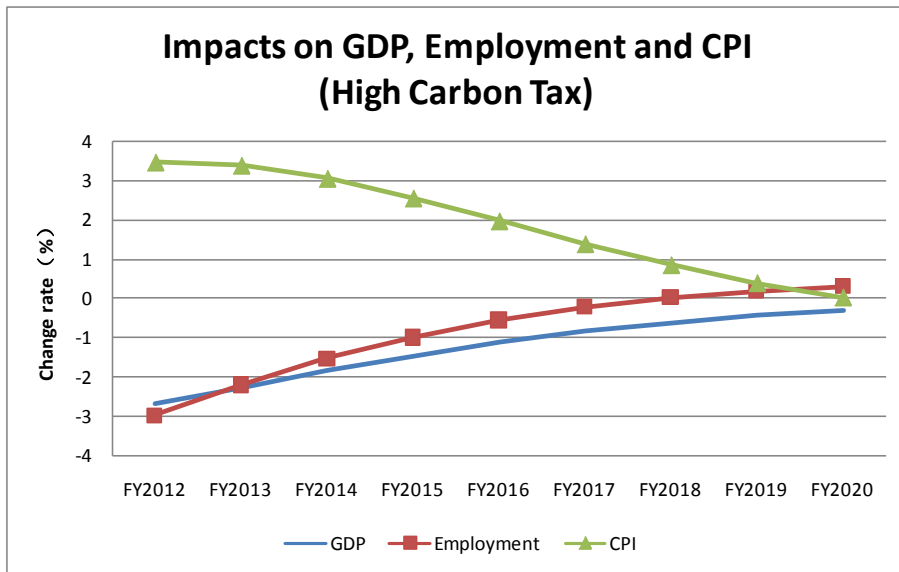
Data and calibration are based on the China's economy 2002 input-output table and 2002~2010 macro economy variables, mainly including consumption, investment, government expenditure, exports and imports, GDP price index, agriculture output, industry output and services output.

This study assesses the sectoral competitiveness from the sectoral output, sectoral value added, sectoral output price and export demand. The loss of competitiveness is believed to be reflected in declining exports, increasing imports in the short-term.

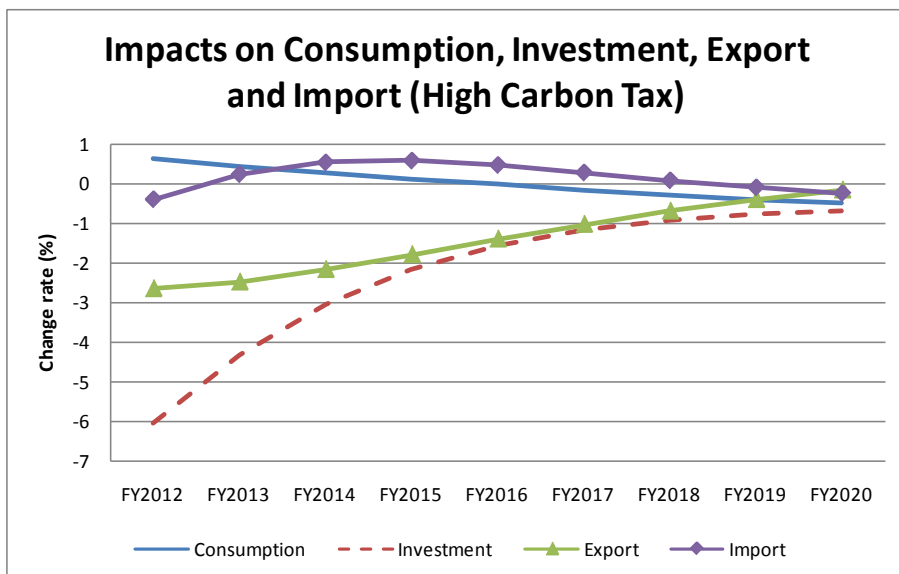
Simulation Results and discussion

Fig. 1 shows the percentage changes of the macroeconomic variables compared with the baseline scenario when the carbon tax rate is RMB100 per ton CO₂ emission. The simulation results show there are negative impacts on GDP, employment, investment and export, but the magnitude of the impacts are relatively small. For carbon tax of RMB100 per ton of CO₂, comparing with the baseline scenario, GDP will fall by 2.8%, employment will fall by 3.0%, export will fall by 2.6%, and investment will get down by 6%. And there are very slight impacts on consumption and import. By contrast, consumer price index increases by 3.5%, need to mention, which is the relative change rate not the absolute change compared with the baseline scenario.

The simulation results above can be explained as following. In the short term, when China levy carbon taxes on CO₂ emissions from fossil fuel combustion and industrial production process, the costs of energy-consumed produces increase, which are passed on to the domestic commodity prices. The returns of labor factors fall relatively. But the tax revenues are transferred to the householders. Thus the disposable incomes and therefore the consumption increase slightly correspondingly. As the costs of intermediate inputs go up, which push up the domestic commodities' prices, the terms of trade get worse and the demand for exports decline. And then the firms decrease the production and willingness-to-invest.



(a)



(b)

Fig. 1 The impacts on macroeconomic variables (tax rate is RMB100 per ton CO₂ emissions)

We examine the impacts of carbon taxes on sectoral competitiveness from the sectoral export demand, sectoral output, sectoral price and sectoral value added. Compared with the baseline scenario, Fig. 2 shows the differences of carbon tax on sectoral export demand. The most five affected industries are IronProc (Manufacture of Iron products), BasicChem (Manufacture of basic chemical raw materials), SpecMch (Manufacture of general purpose and special purpose machinery), ElcMchNEC (Manufacture of other

electrical machinery and equipment) and Furniture (Manufacture of furniture). And the corresponding impacts are -5.6%, -3.05%, -2.86%, -2.62% and -2.59%.

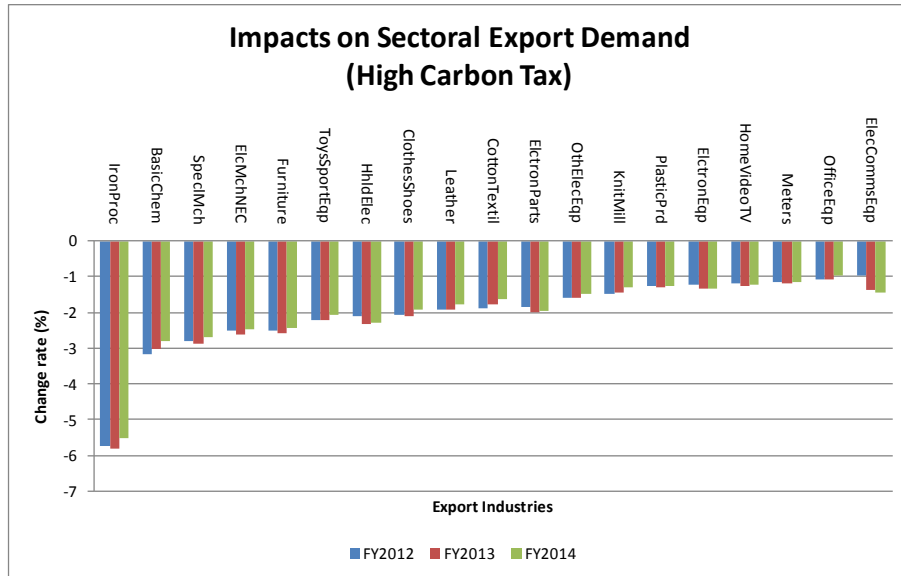


Fig. 2 Impacts of carbon tax on sectoral export demand

Fig. 3 shows the differences of carbon tax on sectoral output. The most five affected industries are IronProc, BasicChem, SpecMch, ElcMchNEC, and Furniture. And the corresponding impacts are -5.77%, -5.60%, -5.02%, -3.66% and -3.03%.

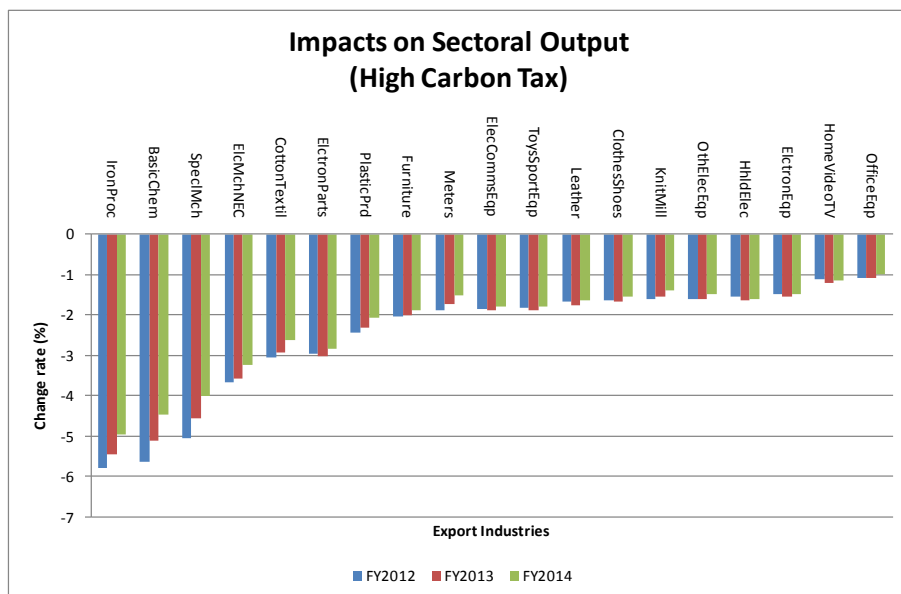


Fig. 3 Impacts of carbon tax on sectoral output

In contrast, the impacts of carbon tax on sectoral output price are different from those on sectoral export demand and output. As shown in Fig. 4, the most five affected industries are BasicChem, IronProc, SpecMch, CottonTextil and ElcMchNEC. And the corresponding impacts of the first financial year are 7.23%, 4.49%, 3.89%, 3.63% and 2.95%.

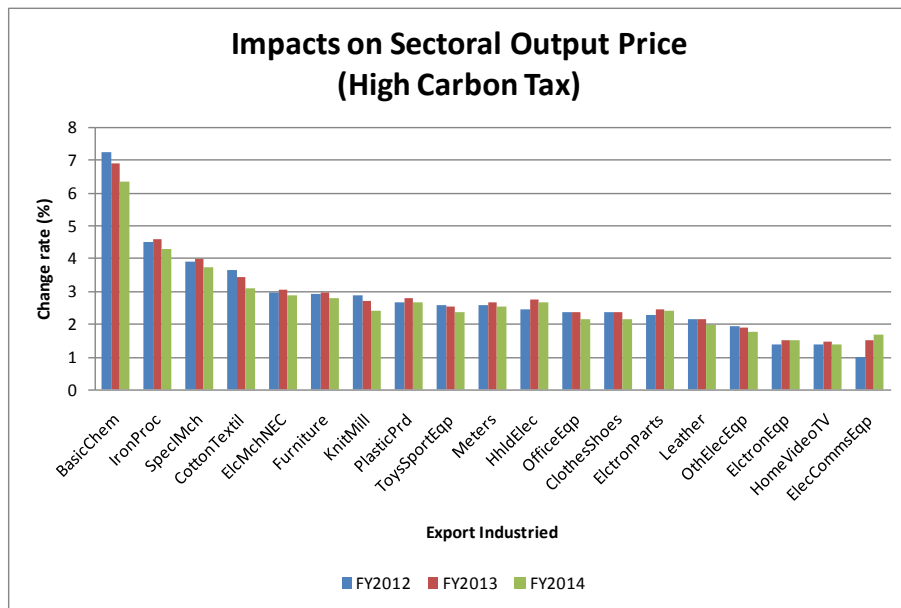


Fig. 4 Impacts of carbon tax on sectoral output price

As both the sectoral output and output price affect the sectoral value-added, some sectors get negative impacts from implementing carbon taxes, such as IronProc, ElecCommsEqp (Manufacture of communication equipment) and SpecMch (Manufacture of general purpose and special purpose machinery), and some industries get benefits from levying carbon taxes, such as KnitMill (Manufacture of knitted fabric and its products), BasicChem and CottonTextil (Spinning and weaving, printing and dyeing of cotton and chemical fiber), as shown in Fig.5.

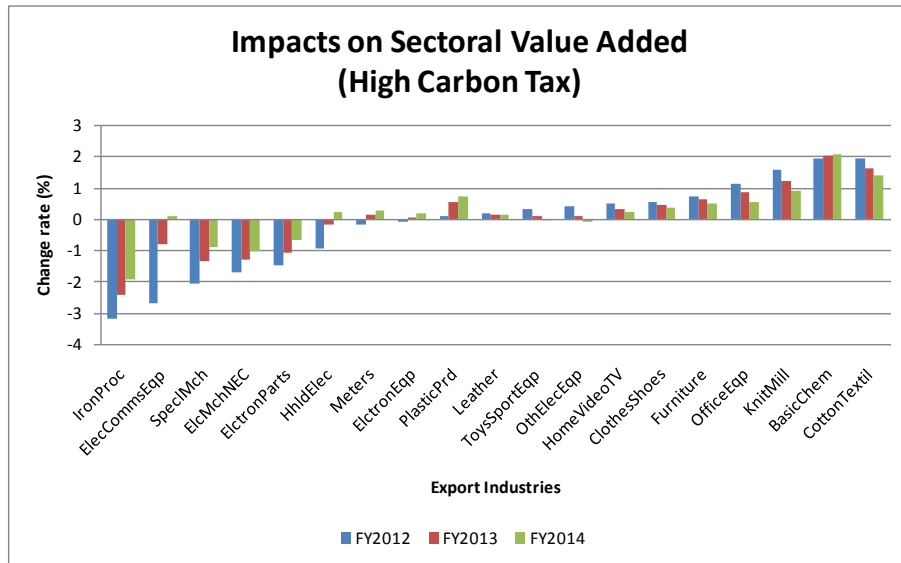


Fig. 5 Impacts of carbon tax on sectoral value added

To sum up, in short term, carbon taxes have relative large negative impacts on export-intensive industries. Where the introduction of carbon taxes forces higher prices on internationally traded goods, tending to make exports less attractive and imports more so, domestic production generally would be expected to decline, implying job losses and other economic shocks to the economy.

Conclusive remarks

As demonstrated in our simulations, in short term, the introduction of carbon tax is the threat of reduced international competitiveness in the most affected sectors of the Chinese economy. One of the reasons is China's GDP is driven too much by the coal-based low energy-efficient industries. In addition, China's economy is particularly open to international trade. The sum of imports and exports measured in units of domestic currency is equivalent to above 60% of China's GDP. China's dependency on international trade and fossil energy intensive economy mean that it could be especially

susceptible to erosion of international competitiveness when implementing carbon taxes.

By simulations, we show that there are design options available which could mitigate the competitiveness impacts due to implementing carbon taxes. A well-designed carbon tax can not only realize the government's objective of 40~45% of carbon intensity abatement, but also ensure that a carbon tax is revenue neutral and distributionally neutral for the Chinese economy.

In addition, from our relevant studies based on this CGE model, carbon taxes have more advantages than low-carbon subsidies to achieving climate change policy goals.

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