Research on Key Technologies of Energy Conservation and Emission Reduction in the New Era

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Abstract. The adjustment of coal energy resource tax is an important price control method to realize energy saving and emission reduction and promote low-carbon economy. The global financial crisis and my country's economic recovery provide a favourable opportunity for coal resource tax adjustment. Combining the current background of the new era of energy conservation and emission reduction, the paper builds a China Energy CGE model based on the actual situation in China, and calculates the impact of ad valorem tax rates on different coal resources. The results of the study found that the coal resource tax reform has a weak negative impact on the economy. Considering the tax return scenario, it cannot only offset the impact, but also drive a small increase in GDP; the coal resource tax reform will not push up the CPI, deregulate electricity prices, and considering the tax rebate has a more obvious restraining effect on prices; the coal resource tax reform is conducive to improving the structure of domestic demand. Similarly, considering the tax rebate scenario, the effect is more obvious. Coal resource tax reform can reduce the output of high-energy-consuming industries, which is conducive to energy conservation and emission reduction.

Keywords: Energy savings and emission reduction, energy resources, coal resources, key technologies, resource tax.

1. Introduction
In the context of the increasing shortage of non-renewable energy resources and the deteriorating environment, the Chinese government actively promotes the development of a low-carbon economy and the construction of a resource-saving society. Among them, the resource tax policy has increasingly become an important measure to protect natural resources and the ecological environment and achieve intergenerational equity [1]. Compared with oil and natural gas, coal plays a more important role in China's economy and energy structure. China's industrialization and urbanization process and coal resources and price advantages determine the current industrial structure of heavy industrialization and the energy structure dominated by coal.

On the one hand, since 2005, coal consumption has remained above 70% of China's primary energy consumption. In the power industry, coal-fired power generation has long accounted for more than 80% of the total power generation. Moreover, this energy structure cannot be changed for a long time, and coal has become an important guarantee for China's energy security. On the other hand, China's coal
utilization technology lags behind the world level, coal utilization efficiency is not high, and the carbon emission coefficient is much higher than that of oil and natural gas, which is an important cause of environmental pollution. In view of the importance of coal resources. Because of its nature and its destructive effect on the environment, the reform of coal resource tax is particularly important. Based on the actual situation of our country, the paper constructs a CGE model of China's energy and measures the effect of ad valorem collection of different coal resource tax rates [2]. On the one hand, it provides reference for similar research in the future on data processing and modular equations. On the other hand, it answers the macroeconomic impact and income distribution effect of fossil energy resource tax reform through the application of the model.

2. Coal energy financial tax CGE model

The CGE model is a mathematical economic model based on Walras' general equilibrium theory. By setting the numbers of an economy as a whole, it examines the changes in the prices, quantities, and market supply and demand of all commodities and factors within the entire economic system caused by changes in an exogenous variable in the economic system, and then examines the economic system from the impact of the transition from one equilibrium state to another on the macroeconomic side. Fiscal policy is an important field of CGE model research [3]. This field focuses on the study of the impact of taxation policies, and also studies the impact analysis of government expenditure policies including subsidies. In recent years, with the increasing awareness of the importance of environmental energy issues, how to use taxation to change the energy consumption structure and promote energy conservation, thereby alleviating energy pressure and improving environmental conditions, has become a hot topic of current CGE research.

![Figure 1. Schematic diagram of the production structure of China Energy's CGE model](image-url)

The production function in the CGE model constructed in this study includes several production factors such as labour, capital, energy and other intermediate inputs. The production module of this model uses a multi-level nested CES function to describe the different substitutions between production factors, including three production factors of capital, labour and energy. In order to study the relationship between energy and economic system in detail, this study conducts a more in-depth decomposition of energy demand. First of all, as a secondary energy source, the elasticity of substitution between thermal
power and other fossil energy is smaller than that between fossil energy, so the energy synthesis is first decomposed into the demand for electricity and fossil energy synthesis. The synthesis of fossil energy is further broken down into the demand for raw coal, crude oil and natural gas (see Figure 1).

2.1. Production module

The study uses a 5-level nested CES function to describe production behaviour: the first level is the synthesis of capital-energy-labour aggregation and non-energy intermediate inputs; the second level is the synthesis of capital-energy aggregation and labour input; the third level contains two There are two dimensions, one is the combination of agricultural laborers and workers, and the other is the combination of capital and energy; the fourth layer also contains two dimensions, one is the combination of technicians and production workers, and the other is the combination of fossil energy and electricity; The fifth layer is the synthesis of oil, natural gas and coal. At each nesting level, the degree of substitution depends on the flexibility of substitution [4]. Only the CES production combination functions of the fifth-level fossil energy synthesis are listed here, and the other functions in the production module will not be repeated:

\[
Q_{EF_a} = a^{\rho_{EF}} \left( \delta^{ef}_{coal_a} \cdot Q_{Ecoal_a}^{\rho_{EF}} + \left(1 - \delta^{ef}_{coal_a}\right) \cdot Q_{Eoi \cdot as_a}^{\rho_{EF}} \right)^{1/\rho_{EF}}, \ a \in A
\]  

That is, for sector a, its demand for fossil energy input \(Q_{EF_a}\) is composed of coal demand \(Q_{Ecoal_a}\) and oil-gas demand \(Q_{Eoi \cdot as_a}\), where the parameters \(\delta^{ef}_{coal_a}\), \(\rho_{EF}\), respectively represent the CES function parameters of fossil energy synthesis, the coal input share parameter of sector a and the correlation coefficient of substitution elasticity between coal and oil-gas. At this time, the optimal factor input and price relationship of fossil energy synthesis are shown in equations (2) and (3):

\[
\frac{P_{Q_{coal'}}}{P_{Q_{oilgas'}}} = \frac{\delta^{ef}_{coal_a}}{1 - \rho_{EF}} \left( \frac{Q_{Eoi \cdot as_a}}{Q_{Ecoal_a}} \right)^{1 - \rho_{EF}}, \ a \in A
\]

\[
P_{EF_a} \cdot Q_{EF_a} = P_{Q_{coal'}} \cdot Q_{Ecoal_a} + P_{Q_{oilgas'}} \cdot Q_{Eoi \cdot as_a}, \ a \in A
\]

Among them, \(P_{EF_a}, P_{Q_{coal'}}, P_{Q_{oilgas'}}\) is the combined fossil energy price, coal price, and oil-gas price of sector a.

2.2. Enterprise Module

\[
EINV = \Sigma_c P_{Q_c} \cdot QINV_c, \ c \in C
\]

Enterprise investment (EINV) is obtained by the sum of the product of the final demand \(QINV_c\) and the commodity price \(P_{Q_c}\) of the enterprise’s investment in various commodities. In this model, the firm’s investment in commodities is determined exogenously.

3. Calculation of the impact of coal resource tax adjustment on the financial economy

3.1. Changes in coal prices and coal consumption under different tax rates

Regarding how to scientifically set the resource tax rate, it is necessary to comprehensively consider the current domestic resource tax level, domestic and foreign energy prices and the actual situation of domestic energy production and consumption, and consider the reasonable resource tax rates of coal,
crude oil and natural gas. First, simulate and analyse the changes in coal prices and coal demand caused by resource taxes of 5%, 10%, 15%, 20%, 25% and 30% on coal [5]. Table 1 lists the changes in coal prices and coal demand before and after the coal resource tax is imposed.

| Project       | 5.00% | 10.00% | 15.00% | 20.00% | 25.00% | 30.00% |
|---------------|-------|--------|--------|--------|--------|--------|
| Coal price (%)| 4.02  | 8.2    | 12.51  | 16.9   | 21.37  | 25.89  |
| Coal Demand (%)| -2.25 | -4.1   | -5.64  | -6.94  | -8.05  | -9.03  |

It can be seen from Table 1 that the price of coal will rise after the coal resource tax is imposed, but the increase is less than the tax rate imposed, which shows that coal production enterprises and coal consumers share this part of the tax. When the tax rate is low, coal production enterprises bear less tax burden. With the increase of tax rate, the tax burden of coal production enterprises continues to increase. Figure 2 vividly reflects this trend. In Figure 2, the line with the node as a triangle represents the difference between the growth rate of coal resource tax and the growth rate of coal price. It is the part where the company cannot completely transfer the coal resource tax to consumers, that is, the part where the company’s unit profit is reduced [6]. The difference between rising tax and price growth rate shows that with the increase of coal resource tax, the profits of coal enterprises are also declining. The reason for this phenomenon is that as the tax rate increases and coal prices continue to rise, coal consumption demand will also decrease. At this time, coal production enterprises can only bear part of the tax burden to reduce prices, and ultimately achieve a balance of supply and demand.

3.2. The impact of different coal resource taxes on my country's GDP
The levy of coal resource tax will increase the production cost of enterprises and restrain consumer demand, which will inevitably have an impact on the macro economy. The simulation results show that when resource taxes of 5%, 10%, 15%, 20%, 25% and 30% are imposed on coal, my country's GDP will be reduced by 0.0008%, 0.0824%, 0.2101%, 0.3628%, 0.5286% and 0.7017% respectively. Figure 3 reflects the impact of different coal resource taxes on my country's GDP. Compared with the impact on coal demand when different coal resource taxes are imposed above, it can be seen that the reduction in coal consumption after the collection of coal resource taxes is greater than the reduction in GDP, which means that the collection of coal resource taxes will reduce the energy consumption per unit of GDP in my country to reach Certain purpose of saving energy and reducing consumption. In addition, it can be seen from Figure 3 that with the increase of the coal resource tax, the impact on GDP has also continued to increase, which shows that the collection of coal resource tax must have a certain limit, and it cannot be solely dependent on the collection of coal resource tax to achieve energy saving and reduction. The purpose of consumption.
3.3. Analysis of industries impaired by different coal resource taxes

Figure 4 shows the output changes of the top 10 most impacted industries under the four scenarios of no tax refund power price control, no tax refund power price marketization, tax refund power price control, and tax refund power price marketization. It is the coal industry that is directly affected. Most of the main damages in different scenarios are the downstream industries of coal. Therefore, the top 10 damaged industries under the four scenarios mostly overlap.

Comparing the four scenarios, it can be found that under the marketization of the electricity price without tax refund, the industry suffers the most negative impact. This is mainly because after the marketization of electricity prices, the rise in coal prices will also be transmitted to electricity prices, which will lead to a new round of rising production costs in downstream industries caused by electricity price increases, resulting in reduced output. Compared with no tax rebate, the impact on the industry under the tax rebate scenario is smaller. This is mainly due to the increase in demand for intermediate inputs due to macroeconomic expansion (increased demand and investment), thereby mitigating the
negative impact of coal resource tax reform. Table 2 shows the output reduction of the four most affected industries.

Table 2. Output reduction of the four most affected industries

| Industry Name                                | 5%   | 10%   | 15%   | 20%   | 25%   | 30%   |
|----------------------------------------------|------|-------|-------|-------|-------|-------|
| Gas production and supply industry (%)       | 0.483| 0.975 | 1.468 | 1.959 | 2.446 | 2.926 |
| Electricity and heat production and supply industry (%) | 0.199| 0.387 | 0.565 | 0.735 | 0.897 | 1.052 |
| Metal smelting and pressing                  | 0.043| 0.088 | 0.136 | 0.185 | 0.236 | 0.288 |
| Chemical industry (%)                        | 0.033| 0.071 | 0.113 | 0.157 | 0.204 | 0.252 |

4. Conclusion
This paper uses the CGE model to estimate the impact of coal resource tax reform on China's economy. The results show that the impact of the coal resource tax reform on the economy is limited. Considering the tax refund can offset the impact and increase GDP slightly; the coal resource tax reform will not push up prices. The deregulation of electricity prices and the consideration of tax refunds will have a more restraining effect on prices. Obviously, the coal resource tax reform is conducive to improving the structure of domestic demand, and the effect of considering tax rebates is more obvious. Coal resource tax reform can reduce the output of high-energy-consuming industries, conducive to energy conservation and emission reduction, and promote the upgrading of the industrial structure. From a benefit point of view, export-oriented enterprises benefit from the non-tax rebate scenario; tax rebates will benefit the private consumer goods sector.

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