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Research article

Impact of energy taxation on economy, environmental and public health quality

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ABSTRACT

This paper argues computable general equilibrium model and assess impact of energy taxation on economy, environmental and public health quality in Tianjin. In order to investigate different energy taxation based on medical cost and labor loss, the computable general equilibrium model integrating with input-output table and social accounting matrix (SAM) was constructed. The medical expense caused by air pollution of Tianjin in 2007 is 396 million yuan and death for 18104 people, which accounted for the total GDP and population 0.754‰ and 1.6‰, respectively. The results show that the enery taxes levy can improve the GDP, but it is only slightly. The energy taxes have adverse impact on energy sector because that the energy cost is increased. The scale of production is reduced, and the capital and labor resources are transferred to low energy consumption low emissions sector. The energy tax levy can reduce air pollutants concentration and improve air environmental quality. The PM_{10}, SO_2 and NO_2 concentration in the energy taxes 5%–30% was reduced by 0.24%–0.24%, 0.09–0.52% and 0.29% –0.52% respectively. The medical expense has little impact on GDP, but labor loss has a certain effect on GDP. For higher energy taxes rate, the health effects on GDP can reach 0.06%–0.16%. This simultaneous economic and environmental improvement and health effect would thus have positive implications regarding energy taxes of the country.

1. Introduction

With growing energy consumption and rapid urbanization, air pollution in China predominantly consists of coal smoke, with suspended particulate matter (PM) and sulfur dioxide as the principal air pollutants. In Chinese cities, however, with the rapid increase in the number of motor vehicles, air pollution has gradually changed from the conventional coal combustion type to the mixed coal combustion/motor vehicle emission type (Kan et al., 2011). It happened the heavy haze pollution in many Chinese cities, especially on January of 2013 and December of 2015 in Beijing-Tianjin-Hebei regions. Haze occurs when particle aerosols accumulate in the air and scatter and absorb solar radiation, leading to atmospheric opacity and impaired visibility (Wang et al., 2012; Xu et al., 2013). Those air pollution problems that result in negative health outcomes and incur real costs on the individuals, the health system, and the economy as a whole (Kira et al., 2012). Indeed air pollution is now the fourth leading risk factor for premature deaths and morbidity in China, accounting for approximately 1.2 million premature deaths in 2010 (Lim et al., 2012; Ouyang, 2014). In 2007, the World Bank estimated that economic losses resulting from damage to health caused by air pollution may be as much as 87 billion dollars per year in China (Lu et al., 2013).

Energy taxes include mainly resource taxes, consume taxes (eg, oil taxes, car/ship taxes), and emission taxes (eg. carbon taxes, sulfur taxes, and nitrogen taxes). Energy taxes can be argued due to various reasons. First of all, indirect taxation on the carbon or energy intensity of goods can raise the prices for certain commodities (e.g. oil fuel and petrol) (Vandyck and Van Regemorter, 2014). Studies usually find that energy taxes are slightly regressive in developed countries (see Speck (1999)), Zhang and Baranzini (2004), Allan and Sukanya (2013). Manresa and Sancho (2005) identified some instances of an effective double dividend following the adoption of energy taxes levied on CO_2 emitters. Ferran Sancho (2010) pointed out the most critical elasticity for achieving a double dividend is the substitution elasticity between labor and capital whereas the elasticity that would generate the highest reduction in carbon dioxide emissions is the substitution elasticity among energy goods by CGE model. Buddelmeyer et al.

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(2012) apply this approach to study the effects of climate change policies on income distribution in Australia. Xu et al. (2015) found coal resource tax reform had a negative influence on Gross Domestic Product (GDP). However, coal resource tax reform can increase regional revenues (especially in resource-rich regions).

In the present, the relationship between the environment, economy and health is one of the key factors that cannot be avoided in the course of China's economic transformation. Energy taxes could increase the economic cost, reduce the economic output, thus hurt economic growth. Meanwhile, the impact of environmental pollution on health will be further transmitted to labour output. Employment is not only affected by the macro-economy, but also is closely related to the changes of environment and health quality. Air quality is closely related to public health and health is a personal economic production capacity, which directly affects the level of individual economic output. The micro-scale personal air quality management was developed by integrated a “virtual sensor” with CFD-based air quality modeling system (Woo et al., 2016). The regional carbon flow mitigation for the spatialized gridded data was obtained in the mountainous areas of Guangyuan (Hao et al., 2016). The chance-constrained two-stage fractional regional energy model (CTFO-REM) is developed for planning regional energy systems (Zhou et al., 2015). The previous studies focused mainly on the impact of energy taxes on economy and environmental quality. But in our paper, we will consider the impact of energy taxation on Economy, environmental and public health quality, and this is key and goal.

Computable general equilibrium (CGE) modeling is the primary analytical tool available for conducting economic analyses of energy, economy, environmental policy and health effect. CGE models are simulations that combine the abstract general equilibrium structure formalized by Arrow and Debreu with realistic economic data to solve numerically for the levels of supply, demand and price that support equilibrium across a specified set of markets (Sue, 2004). The environmental CGE comes from the theory of general equilibrium, and establishs the numerical relationship between environment and economy systems. It is suitable for the environmental CGE to analyze economy policy and environmental policy in region economy (Bohringer et al., 2012, 2014). CGE model can simulate the implementation of different energy and environment policy and the population health status of the comprehensive impact of the national economy. Some researchers applying CGE models in environmental health assessment, enriched the content of CGE model (Yang and Wan, 2005; Jiang Lin, 2006).

A few studies use CGE modeling approach in order to assess economic impacts over time (Holland et al., 2005; Mayeres and van Regemorter, 2008). In their approach, labor and leisure loss caused by air pollution can affect market equilibrium in the future. In their CGE models, however, premature deaths due to chronic exposure are dealt with in the same manner as those due to acute exposure, which inaccurately captures the flow of lost labor over time. The researcher apply a CGE model of the economy to estimate the total economic impact, valuing both work and non-work (i.e., leisure) time as well as the economic cost of reallocating economic resources to the health care sector. An important implication of this approach demonstrated by previous applications is that economic damages accumulate lost income in earlier years means lower GDP and savings, and therefore less investment and growth over time (Kyung-Min Nam et al., 2010). The paper constructed a CGE model to analysis the impact of carbon emissions trading on Tianjing industries' competitiveness. The implementation of carbon emissions trading has a little influence on Tianjin economy. The greatest effect was the electric industry, the biggest drop in value-added (−0.8%) and sending out (−4.4%) and highest rise in output prices (0.82%) (Wang, 2015).

The city of Tianjin is located in northern China, and has a developed industrial sector, which leads to frequent haze and other air pollution problems. However, limited research has been done on impact of energy taxation on economy, environmental and public health quality using CGE model for Tianjin. In Tianjin, the environmental taxes and consumption taxes were gradually imposed on the many sectors, but energy taxes was still implemented now. The paper consider not only the impact of energy taxation on the economy and environmental quality, but also the impact on public health. Section 2 we describe the model and its main model method. Section 3 explains air quality data. Health effects and medical expenses are presented in Section 4. Section 5 elaborates the simulation and result in computational general equilibrium modeling. Section 6 concludes the paper. Discussion is showed in Section 7.

2. Theoretical framework and method

The paper selected the CGE model as the main model, and built the relationship between air pollution and health hazard using the model of atmospheric environment quality and dose-response model, and made the health hazard monetization and gave feedback to the CGE model. Eventually, the relationship of economic activities, environmental pollution and health effects was established, which is shown in Fig. 1.

In this study, the modeling process and procedures as follows,

First, the energy consumption sectors are formed into energy sector, high energy consuming and high emission sector, and low energy consuming and low emission sector. The output of this three production section can be obtained by production activities of input of labor, capital, energy and other production ingredient.

Second, there are not only production output, but also pollutant emissions (such as PM_{10}, SO_2 and NO_2) for a series of activities. The pollutant emission can have effect on personal health hazard, and if the pollutant emission reaches a certain concentration, this will cause the population disease, even death.

Third, it can cause labor force loss and medical cost if the residents get illness. On one hand, labor force loss can have effect on production ingredient input, and then have effect on the production output. On the other hand, extra medical costs will increase the expenditure of residents, and then the income of residents will decrease due to labor loss. This reduced the life necessary consumption and the demand of each sector production output.

Fourth, the above change will reflect on the residents' consumption and production module in CGE model. So, we will draw a conclusion of impact of energy taxation on economy, environmental and public health quality.

We develop a regional, multi-sector CGE model for the purpose

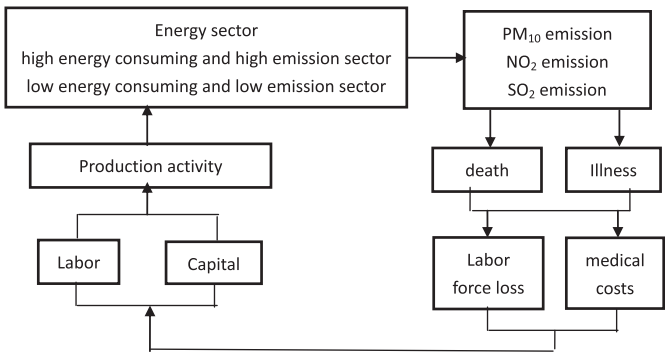

Fig. 1. The relationship of economic activities, environmental pollution and health effects.