2021 International Conference on Applied Mathematics, Modeling and Computer Simulation (AMMCS 2021)

CS195

An integrated assessment model for evaluating air pollution mitigation policy

Na Li
School of Economics and Management, University of Chinese Academy of Sciences

Introduction

Comprehensive evaluation of anti-policies to tackle the severe haze problem is of great scientific significance. This paper develops an integrated evaluation model of air pollution control, embedded three sub-models and feedbacks between them.

Method

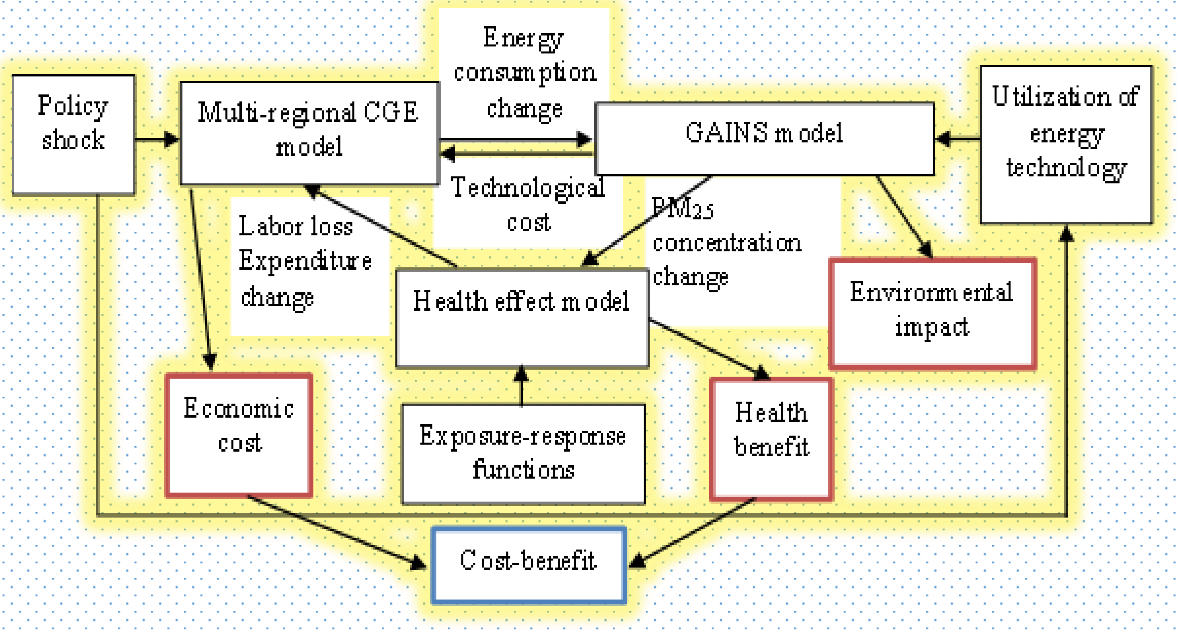
The comprehensive assessment model of air pollution constructed in this paper includes three main models: a China's multi-regional economy-energy-environment CGE model, an air quality model based on GAINS model and a health effect model. By soft-link with the three models, taking into account the linkages and feedback among them, the integrated assessment model can provide valuations of relevant policies from the interdisciplinary perspectives.

China's multi-regional CGE model

The model includes 30 provincial regions-consisting of Hebei, Beijing, Tianjin and other regions, 17 production departments, 3 kinds of primary factors for production and 4 kinds of emissions (primary $PM_{2.5}$, NOx, SO_2 and VOCs). To decide separately the supply or demand of goods and primary factors, the agents in the market maximize their objective functions.

The air quality model based on GAINS model

Based on the GAINS-China model, we calculate the resulting structures of energy consumption and energy technology utilization for Chinese different regions, sectors and technical equipment caused by specified packages of measures, and input them into the model, to make it applicable for China air pollution control analysis.



Basic framework of integrated assessment model

The health effect model

A China-specific linear function is built for $PM_{2.5}$-related morbidity. The number of health endpoints (EP) is estimated by multiplying population and reported cause-specific mortality rate with the population attributable fraction. We can obtain the additional health expenditure based on the product of total endpoints and the expenses of hospital admission and outpatient for each endpoint. Last, we calculate the value of health endpoint (VE) according to the willingness to pay (WTP) method, in which we use a per capita GDP index to estimate the value of statistical life.

$$VE_{la,lo,y,t}=EP_{la,lo,y,t}\times WTP_{la,lo,y,t}\times\left(\frac{PGDP_{la,lo,y}}{PGDP_{2010}}\right)^{0.5}$$

The linkages of sub-models

First, the change of energy consumption simulated by the multi-regional CGE model, is put into the air quality model with the energy technological improvement caused by the policy to simulate the $PM_{2.5}$ concentration. Then, the changed $PM_{2.5}$ concentration is taken into the health effect model to simulate the change of the health damage.

Last, the resulting labor loss and medical expenditure from the health effect model, and the technological cost from the air quality model are all input into the CGE model to simulate it again, to obtain the final economic cost.

The CBA analysis for Jing-Jin-Ji region

The direct reduction data, and the data of direct abatement expenditure costs for related policies (Table 1) are estimated according to the air policy plans, literature study and statistical data.

The ratio of benefit and cost (RBT) can be calculated based on total cost (TC) and health benefit (HB).

Table 1. The expenditure costs of direct abatement for the Action Plan and Enhanced policies (100 million Yuan)

Policies	Sectors	Beijing	Tianjin	Hebei
Structure adjustment	Industry	212.33	95.24	380.95
End-of-pipe treatment	Power and heat supply	3.21	125.57	540.64
	Industry sector	27.42	33.04	102.02
	Metals smelting and pressing-steel	0	12.35	89.28
	Non-metallic mineral products manufacturing-cement	0.13	0.08	1.43
Reductions from vehicles	Transportation	185.23	41.24	151.42
VOC reduction	Petrochemical Industry	27.69	42.11	22.96

Conclusion

This paper develops an integrated evaluation model of air pollution control, taking the Jing-Jin-Ji region as an example. This approach can be applied for other regions in related study.