MARGINALABATEMENTCOST OF CO2 EMISSIONS IN CHINA'S NATIONWIDE EMISSIONS PERMIT TRADING SCHEME: ASTOCHASTICSEMI-NONPARAMETRIC ENVELOPMENT OF DATA APPROACH

Yujiao Xian,Center for Energy and Environmental Policy Research, School of Management and Economics, Beijing Institute of Technology, (+86) 15201609846, xianyujiao@qq.com

Andrew L. Johnson,Department of Industrial and Systems Engineering, Texas A&M University, (+1) 9794582356, ajohnson@tamu.edu

Ke Wang, Center for Energy and Environmental Policy Research, School of Management and Economics, Beijing Institute of Technology, (+86)-10-68918651, wangke03@yeah.net

Overview

As the world's largest energy consumer and carbon dioxide (CO_2) emitter, China recently adopted a series of international commitments and national targets for carbon emissions control. The tradable permit system, which aims to achieve reduction of carbon emissions at minimal cost, can be considered an efficient market-based policy instrument. China has established the pilot carbon emissions permit trading schemes (ETS) in seven regions since 2013/2014 and launched a nationwide carbon emissions permit trading scheme in the power industry by the end of 2017.In the following years, the nationwide ETS will cover more high emissions industries. The estimation of shadow price of CO_2 emissions would help to identify the marginal abatement cost of CO_2 emissions, which provides policy makers with useful information on allocating carbon emission permits.

Frontier estimation is the key to measure marginal abatement cost of CO_2 emissions. This field is classified into two approach: the nonparametric estimation approach and the parametric estimation approach. The former, which lies in the axiomatic, dose not assume a specific functional from in advance. However, this approach attributes all deviation from the production frontier to technical inefficiency. The latter has the advantage of stochastic treatment of the deviation, which is decomposes into a random disturbance term and a nonnegative inefficiency term. However, this approach requires an ex ante form of production function. Thus, the emerging techniques of these two approaches has been recognized recently.

In this study, a new three-stage approach is proposed, referred to as stochastic semi-nonparametric envelopment of data (StoNED). Including the power industry, this study covers seven industries using provincial panel data that were in operation during 2011 to 2015.

Methods

The first stage develops a convex nonparametric least squares (CNLS) optimization programming to estimate the shape of average production function which satisfies the production axioms of continuity, convexity, monotonicity, weak disposability and "no free lunch". Imposing additional distributional assumption on the inefficiency term and the random disturbance term, the second stage is first to estimate the conditional expectations of inefficiency using the method of moments based on the CNLS residuals. Furthermore, the production frontier can be obtained through the expected inefficiency and the average production function.In the third stage, three directions (e.g., (0.1), (1,0) and (1,1)), which present three policies, are selected to measure the shadow price and inefficiency for each province.

Results

Our estimation results mainly show that (i) Different policies would lead to different marginal abatement cost of CO2 emissions, especially for the Petroleum Processing and Coking industry sector, Raw Chemical Materials and Chemical Products industry sector and Electric Power, Steam and Hot Water Production and Supply industry sector, (ii) The marginal abatement cost of CO2 emissions has significant difference among different industries, and the average industrial marginal abatement cost of CO2 emissions ranges from 856 Yuan ($134) to 266,163 Yuan ($41,686) per ton of CO2 emissions, and (iii) The raw chemical materials and chemical products industry shows the highest marginal abatement cost of CO2 emissions in our sample, whereas the Electric power, steam and hot water production and supply industry shows the lowest one.

Conclusions

Carbon emissions permit trading schemes can be considered an effective approach to ease environmental pressure. To estimate the marginal abatement cost of CO2 emissions at the beginning of trading for annual allowance, this paper proposed a new three-stage StonNED method to estimate the production frontier when CO2 emissions are a result of the production process.

From the results in this study, we recommend that the heterogeneity of production technology and marginal abatement cost of CO2 emissions among industries should be considered when the policy makers assign the initial emission right. Moreover, the formulation of policy on carbon control should be diversified for different industries and regions.