ABATEMENT PERFORMANCE EVALUATION OF CLIMATE POLICY IN CHINA – A STUDY BASED ON REGIONAL INTEGRATED ASSESSMENT MODEL

[Pan PENG, CEEP, Institute of Policy and Management, Chinese Academy of Sciences, pengpan43@126.com]
[Lei ZHU, CEEP, Institute of Policy and Management, Chinese Academy of Sciences, lions85509050@gmail.com]
[Ying FAN, CEEP, Institute of Policy and Management, Chinese Academy of Sciences, yfan@casipm.ac.cn]

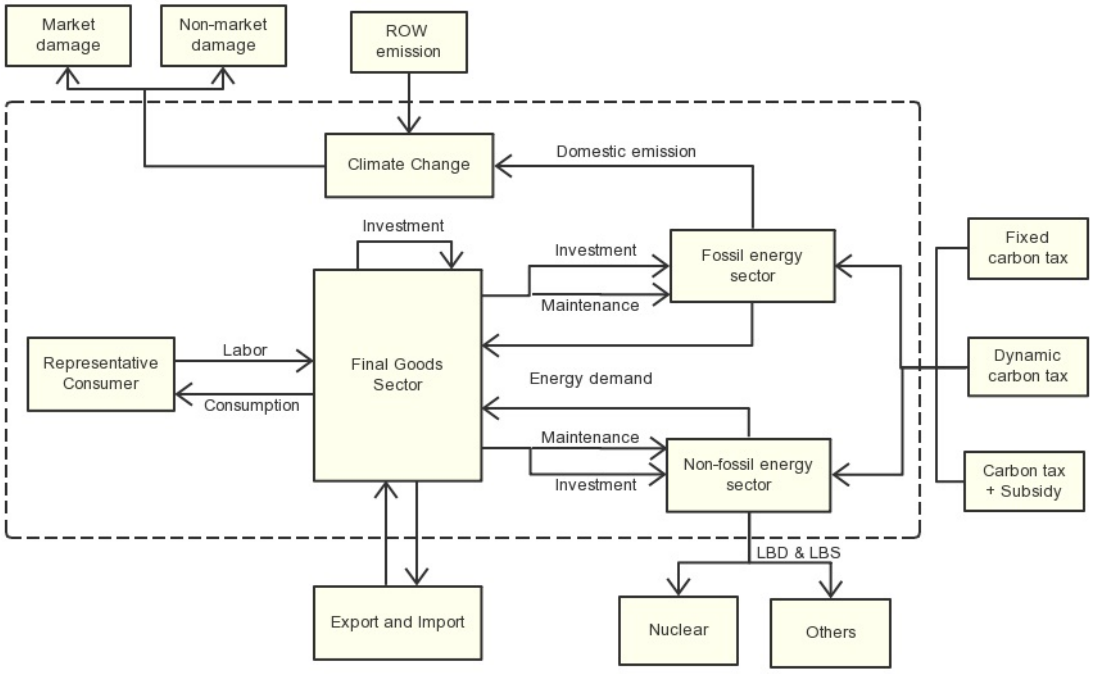
Overview

This paper studies the abatement performance of three possible climate policies (fixed carbon tax, dynamic carbon tax, and tax-subsidies mixed policy) in China. We established a regional Integrated Assessment Model based on DEMETER (van der Zwaan et al., 2002), and with four key improvements: climate damage description, multiple energy technology deviding, two factors learning curve, export & import trade.

In order to have a more comprehensive analysis on the abatement performance, four types of macro-cost have been defined as the index to measure the policy abatement performace: GDP Loss, Consumption Loss, Incremental Energy Cost and Incremental Energy Investment, respectively. And the analysis is presented from two perspectives: cost benefit analyisis (CBA), and cost effective analyisis (CEA). And each of the performance index will be measured under both of the CBA and CEA. And China is taken as the case study of our model.

Methods

Modeling Framework is presented as below:



In general, the itemlized features of our model can be summarized as below:

(a) General Equilibrium Analysis and Demeter-China model, to evaluate abatement performance of different climate policies in China, which is formulated as a nonlinear optimization model that maximizes utility subject to constraints defining the aggregate economic equilibrium.

(b) Our model is a single regional Integrated Assessment Model based on DEMETER (van der Zwaan et al., 2002) with five additional parts: climate damage describing, energy technology deviding, two factors learning curve, country's export & import trade and abatement performance indicators setting.

(c) For climate damage submodel, we defined climate damage as two parts: market damage and non-market damage (Manne et al., 1995).

(d) Different with global DEMETER model, we divided non-fossil energy as two specific technologies: one is nuclear energy, another is renewable energy.

(e) Induce Technology Change process in our Demeter-China model was described with Two Factors Learning Curve (Barreto and Kypreos, 2004): learning by doing and learning by searching.

(f) As we know, the global IAM consider international trade as a closed loop, which means that export equal to import. But for a country, this can not be true. Therefore, we give a reasonable and suitable assumption to form two equations of export and import in China (Zhu et al., 2014).

(g) From three perspectives, we set reasonable abatement performance indicators to evaluate and compare kinds of climate policies in China each other.

Results

Based on our study, we compare three groups of case setting to investigate the abatement performance of different climate policies in China: group one is used to study and compare the performance of fixed carbon tax and dynamic carbon tax; group two consider effect on performance of fixed and dynamic carbon tax under two possible circumstances of changes in domestic emission share: "burden" and "freeriding"; group three evaluate the abatement performance of mixed policy, and also consider the effects of "burden" and "free-riding" on performance of mixed policy. Therefore, the main findings could be listed as follows:

(a) Under CEA analysis, the mixed policy have minimal GDP Loss Cost and Added Energy Cost, and differences of Consumption Loss Cost (or Added Energy Investment Cost) of three policies are very small.
(b) Under CBA Analysis, mixed policy only perform better in the index of GDP Loss. And dynamic carbon tax would perform much better than others in the index of Added Energy Cost, while fixed carbon tax perform better in the index of Consumption Loss and Added Energy Investment Cost.
(c) Under CEA analysis, all four cost index will be increased with "burden" under three policies, while they all will be decreased with "free-riding". On the contrast, for CBA analysis, except for the index of GDP Loss, all kinds of cost benefit index will be decreased with "burden" under three policies, while all of these index will be increased with "free-riding" under three policies.

Conclusions

(a) Different climate policies has different abatement performance, even in the same emission reduction targets, emissions reduction pathways, costs and benefits of different policies also have very different trajectories.The choose of suitable climate policies in the specific region will be depended on the angle which decision-maker concerned mostly.
(b) In addition, due to the variability of different climate policies' performance in the earlier time, a flexible policy strategy would be preferred in mitigating GHG emissions in China in near-mid term. And with strong convergence on the performace of different policies in later time, more stable strategy could avoid potential adjustment cost.

References

1. Barreto, L., Kypreos, S, 2004. Endogenizing R&D and market experience in the "bottom-up" energy-systems ERIS model. Technovation, 24(8), 615-629.
2. Bollen, J., van der Zwaan, B., Brink, C., Eerens, H, 2009. Local air pollution and global climate change: A combined cost-benefit analysis. Resource and Energy Economics, 31(3), 161-181.
3. Gerlagh, R., van der Zwaan, B, 2003. Gross world product and consumption in a global warming model with endogenous technological change. Resource and Energy Economics, 25(1), 35-57.
4. Gerlagh, R., van der Zwaan, B, 2004. A sensitivity analysis of timing and costs of greenhouse gas emission reductions. Climatic Change, 65(1-2), 39-71.
5. Gerlagh, R., van der Zwaan, B, 2006. Options and Instruments for a Deep Cut in CO_2 Emissions: Carbon Dioxide Capture or Renewables, Taxes or Subsidies? The Energy Journal, 25-48.

6. Gerlagh R., van der Zwaan, B., M.W. Hofkes, and G. Klaassen, 2004, Impacts of CO2 taxes when there are niche markets and learning by doing, Environmental and Resource Economics 28:367-394.
7. Goulder, L.H., Mathai, K., 2000. Optimal CO2 abatement in the presence of induced technological change. Journal of Environmental Economics and Management 39, 1-38.
8. Manne, A., Mendelson, R., Richels, R.G., 1995. MERGE: a model for evaluating regional and global effects of GHG reduction policies. Energy Policy 23 (1), 17–34.
9. Van der Zwaan, B., Gerlagh, R., Klaassen, G., Schrattenholzer, L., 2002. Endogenous technological change in climate change modelling. Energy Economics 24, 1–19.
10. Zhu, L., Duan, H.B., Fan, Y, 2014. CO2 mitigation potential of CCS in China e an evaluation based on an integrated assessment model. Journal of Cleaner Production (in press).