Executive Summary

REGIONAL OPPORTUNITIES FOR CHINA TO GO LOW-CARBON: RESULTS FROM THE REEC MODEL

Hongbo Duan[A] ***Lei Zhu***[B] ***Gürkan Kumbaroğlu***[C] ***Ying Fan***[B]

[A] *School of Economics and Management, University of Chinese Academy of Sciences, Beijing, China.*

[B] *School of Economics & Management, Beihang University, Beijing 100191 Beijing, China.*

[C] *Department of Industrial Engineering, Boğazici University, Istanbul, Turkey.*

China has stepped into a particular development phase that differs from any other historical period, since it is committed to peak its CO_2 emissions at around 2030 and meet at least 20% of energy demand with non-fossil energy. Facing this situation, several key challenges are left behind: 1) restructuring fossil energy consumption and promoting carbon sequestration; 2) improving energy efficiency to control total energy demand; 3) accelerating the diffusion of non-fossil energy technologies. The government has planned to establish a unified national carbon trading market by 2017, and we initiate this research to investigate the long-term impacts of ETS on domestic socio-economic development, energy consumption, and energy technology evolution, from both national and regional perspectives.

Motivations underlying the research

The Emission Trading Scheme (ETS) is widely regarded as one of effective tools to cope with carbon mitigation issues. And the outline of China's 12th Five-Year Plan has clearly proposed to launch regional carbon trading markets; as the first carbon market pilot, Shenzhen, started to open and trade on June 18, 2013, the others are followed gradually. Based on these experiences, the government has planned to establish a unified national carbon trading market by 2017. It can be expected that the carbon trading system will play a significant role in reducing carbon intensity and controlling carbon emissions. However, as compared to the EU ETS, ETS in China is very young and just in its nascent stage, at which substantial work are needed to accelerate the transition from its cradle phrase to the mature phrase.

In this context, we initiate this research and try to: examine the potential impacts of ETS-based carbon reduction on energy production and consumption; explore the differences in efficiency of CO_2 reduction between ETS and carbon tax; most importantly, investigate the long-term influences of ETS on evolution of non-fossil energy technologies, from both national and regional perspectives.

A short account of the research performed;

In this work, we develop an extended Ramsey model, the Regional Energy Economy Carbon model (REEC), to achieve our research goals. REEC is a dynamic multi-regional model which consists of three interdependent modules: economy, energy, and environment. It is calibrated with Chinese data. We chose 2007 as a base year and cover a planning horizon of 50 years from 2007 to 2057; 2012 is the most recent year for which data is available. We divide China into eight regions in terms of the official habitual region division.

REEC is written in the General Algebraic Modeling System (GAMS) and optimally solved by employing the CONOPT solver. The simulation horizon of REEC ranges from 2007 to 2057, operating in five-year periods. All flow variables are defined as annual flows, while the stock variables measure five-year values at the end of a period, including the

knowledge stock from LBD. The optimal solution of REEC is cooperative, which means that the objective of this model is to maximize the joint welfare of all regions.

The REEC model features three aspects: first, it provide a specific tow-dimensional integrated framework that can geographically consider the interactive relation among different regions and dynamically describe the long-term relationships between the economy, energy system and emissions; second, policy comparison analysis enables the targeted model to incorporate and distinguish both ETS and carbon tax mechanism; lastly, multiple carbon-free technologies evolution could be well considered simultaneously in this model framework.

The main conclusions

The main results could be summarized as below:

−Both production of fossil and non-fossil energy encounter a negative impact of carbon reduction; the difference of influences on the energy consumption between ETS and carbon tax is not significant at the national level, in spite of some regional differences, which implies that change of energy consumption at the national level should not be viewed as the deterministic factor for policy makers to make a choice between ETS and carbon tax, if regional differences in energy demand are not the main concern.

−ETS and harmonized carbon tax bring significant and different effects to carbon reduction for achieving the same carbon-control target. As compared to carbon taxes, ETS is more favorable for mitigating CO_2 emissions, which is true for most of the regions. The impacts of ETS and carbon tax on carbon mitigation encounter a little difference from the national perspective. Besides, as compared to ETS, carbon tax policy is more cost-effective for achieving the same carbon-control target in the long run, from both national and regional perspectives.

−There are some potential relationships between the development of non-fossil technology and positions of emitters in the emissions trading market. In specific, it is found that sellers and buyers play discrepant roles in promoting the diffusion of low-carbon technologies indeed, and the regions acting as sellers in the emissions trading market encounter accelerated rates of technological diffusion.

Potential benefits, applications and policy implications of the work

Some informative policy insights are provided through this study:

(i) Although the carbon tax performs a little better than ETS in response to the development of non-fossil technology, it's rather difficult for niche market of renewables to grow from inception phase to mature phase, even in the presence of carbon control; this means that some other supplementary instruments, such as direct subsidies and R&D investment incentivization, might be needed to achieve more breakthroughs. Therefore, the policymakers should fully understand the long-term process of transiting energy supply from fossil to non-fossil, and put more emphasis on building a whole package of comprehensive policy system to mature the non-fossil energy market.

(ii) At the national level, the 'one size fits all' policy must be avoided when non-fossil energy development plan are made, and a differentiation policies should be adopted instead to balance the regional technological development; at the regional level, the government should be paid attention to coordinate the development of non-fossil technologies with carbon reduction actions, permit buyers and sellers may need different policy portfolios to promote the technological diffusion.