Assessment of impacts of Hubei Pilot emission trading schemes in China – A CGE-analysis using TermCO2 model

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HIGHLIGHTS

• The economic and environmental impacts of the Hubei Pilot ETS are assessed by applying TermCO2 model.
• The carbon emission of Hubei is reduced by 1.00% and the provincial GDP declines by 0.06% in 2014.
• Elasticity of GDP to carbon reduction is 0.06, and the average GDP loss is 212.09 Yuan per ton in Hubei.
• The provincial employment and investment rate decreases by 0.09% and 0.33% respectively.

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ABSTRACT

Among the seven Pilot Emission Trading Schemes (ETS) in China, the ETS in Hubei province exerts significant influences. And Hubei’s economic and social contexts are very similar to China as a whole. By applying a Chinese multi-regional general equilibrium model (TermCO2), this paper simulates the economic and environmental impacts of the Hubei Pilot ETS, under a scenario based on the institutional factors of this Pilot ETS and careful consideration is given to ETS coverage. The results show that the Hubei Pilot ETS has significantly reduced carbon emission while its adverse impact on economy is relatively negligible. The carbon emission of Hubei in 2014 is reduced by 1.00% (6.98 million tons) at an average carbon price of 34.31 Yuan per ton. However, the provincial GDP only declines slightly by 0.06% (1.48 billion Yuan) and the average GDP loss is 212.09 Yuan per ton. Meanwhile, Hubei’s economic structure has been adjusted, and the provincial employment and investment rate decreases by 0.09% and 0.33% respectively. However, due to income distribution effect caused by free allowances, the provincial household consumption increases by 0.35% and the consumer price index (CPI) increases slightly by about 0.02%.

1. Introduction

Climate change has been a challenge for all human beings of contemporary society. China has been actively involved in controlling greenhouse gas (GHG) emission and building its capacity to adapt to climate change. In 2009, China announced internationally that by 2020 it will reduce carbon dioxide emissions per unit of GDP by 40–45% from the 2005 level. Recognizing the high costs of command and control measures during the 11th Five Year Plan (2006–2010), China has increasingly focused on market-based measures such as emission trading schemes (ETS) to achieve this target. In theory, ETS allows more flexibility on where GHG emissions are to be reduced and creates a continuous incentive for improvement. As a result, emission cuts can be achieved at least cost by trading between high and low marginal cost emitters. In practice, the Clean Development Mechanism (CDM) has increased the familiarity of Chinese government with ETS and has simultaneously established several key elements of ETS in China. Therefore, China is attempting to establish ETS step by step to explore a new mode of low-carbon development.

As a first step, China announced to launch seven Pilot ETSs in two provinces (Hubei and Guangdong) and five cities (Beijing, Shanghai, Shenzhen, Tianjin and Chongqing) in 2011 [1]. The Pilot ETSs are intended to gain experience associated with implementation of ETS and to identify challenges that should be resolved before moving to a nationwide ETS. During the pilot phase, local governments have the flexibility to design their ETSs according
to local circumstances. By the end of 2014, these seven Pilot ETSs have been operated cumulatively. The seven Pilot ETSs cover 18% of China’s population, and 30% of its national GDP. It is estimated that these Pilot ETSs could eventually regulate between 0.8 and 1.0 billion tons of carbon dioxide emissions, and become the second largest ETS after EU ETS in terms of allowance scale [2]. These Pilot ETSs differ in the extent of the cap, industrial coverage, threshold for covered entities, allocation of allowances and other design features that reflect diverse settings and priorities [3]. And China’s Pilot ETSs have some effective features in allowance allocation and distribution, which include an allowance allocation rule based on historical emissions combined with some benchmarking, a free allowance distribution arrangement combined with some level of auction, and pre-determined allowances combined with ex-post allowance adjustments [4].

In 2015, China announced its enhanced actions and measures on climate change in a document entitled Enhanced Actions on Climate Change, which proposed a number of voluntary goals: carbon dioxide emissions would peak in 2030; carbon dioxide emissions per unit of GDP would decline by 60–65% compared with the level of 2005. To achieve these goals, China is going to implement a nationwide ETS in 2017 based on the Pilot ETSs, implying that the performance of those Pilot ETSs will to a large extent determine the future of ETS in China [5]. It is noteworthy that China has made active contribution to Paris Agreement and presents its new role as a world leader in combating climate change. China is the first developing country to regulate carbon dioxide emissions through a cap-and-trade system. Once China’s national carbon market is established, China will overtake the EU ETS to become the largest carbon market in the world. China’s experience and lessons with Pilot ETSs will also affect the setting up of a global carbon market, and may help other developing countries construct their ETSs. Therefore, it is necessary to make a quantitative estimation for Pilot ETSs, especially their economic and environmental effects, which will provide a basis for scientific decisions on establishing a nationwide ETS.

This paper selects Hubei Pilot ETS as an example to assess the economic and environmental impacts of China’s Pilot ETSs for three main reasons. Firstly, Hubei is very similar to China as a whole in a number of ways. Its stage of development, in terms of GDP per capita, is merely slightly higher than China’s national average (42,539 Yuan in Hubei and 41,805 Yuan in China). The industrial sector is the major source of economic growth and carbon dioxide emissions in Hubei that is the most similar to China’s national industrial structure. Like China, Hubei relies heavily on coal as its primary energy source. These characteristics of Hubei make it very representative of China [6]. Secondly, Hubei Pilot ETS has distinctive characteristics of its socio-economic and energy contexts. At present, Hubei is still in the process of rapid industrialization. Hubei is the only pilot in central China with a heavy industrial structure, and it is also the only one to base its coverage entirely on energy consumption [7]. Thirdly, the Hubei Pilot ETS has been started for more than one year and has been a pioneer among all pilots for its stable operating system, constant innovation in carbon finance and various top ranking trading indexes nationwide. As shown in Fig. 1, by the end of March 2016, Hubei Pilot’s total trading volume reached 24.97 million tons, which accounts for 57% of seven Pilot ETSs’ total trading volume. The turnover was approximate 607.44 million Yuan, which accounts for 46% of seven Pilot ETSs’ total turnover.

Consequently, assessing the impacts of Hubei Pilot ETS on economy and environment not only contributes to their own lessons learned, but also has important implications on establishing a nationwide ETS. Thus, we use a Chinese multi-regional general equilibrium model (TermCO2) and set up a scenario based on the institutional factors of Hubei Pilot ETS, to simulate the Pilot ETS’s economic and environmental impacts in 2014. In order to analyze accurately the impacts of Hubei Pilot ETS, this paper employs a number of innovative approaches. Firstly, based on TermCO2, we develop Carbon ETS module, which is not only able to analyze the impacts of Hubei Pilot ETS on the province’s economy, but also assess the influences between provinces such as the inter-provincial trade flows. Secondly, the scenario is set up according to the institutional factors of Hubei Pilot ETS, and careful consideration is given to industrial level free allowances. We estimate the reduction rate of the covered industry’s allowance using firm-level data, which helps us obtain precise evaluation of economic and environmental influences. Thirdly, by using industrial level data, this paper is able to evaluate the impacts of Hubei Pilot ETS on industrial output, price, employment and rate of capital return, as well as the influences between industries.

This paper is organized as follows. Section 2 reviews the relevant literatures studying the carbon ETS’s impacts. Section 3

![Volume of Carbon Trading (Million Tons)](Image)

![Value of Carbon Trading (Million Yuan)](Image)

Fig. 1. Volume and value of carbon trading in seven Pilot ETSs as of March 31, 2016. Data source: China Hubei Emission Exchange, 2016.

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