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The dynamic linkage effect between energy and emissions allowances price for regional emissions trading scheme pilots in China

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ABSTRACT

China's emissions trading scheme (CETS) pilots are emerging and fragmented markets; these emissions allowances markets may exhibit a different fundamental price process from the European Union's (EU) and the United States' (US) emissions trading scheme (ETS). The dynamic linkage effects between energy and emissions allowances prices are investigated for regional ETS pilots in China using cointegration techniques. The empirical results confirm that, in the long run, coal, oil and natural gas prices are the main determinant factors of regional emissions allowances prices, except for the second phase Beijing ETS pilots; however, their long-run cointegration relationships in the Beijing and Shanghai pilots are not exactly in line with the Guangdong and Hubei pilots. In the short run, the changes in oil and natural gas prices in the second phase Beijing ETS pilot, the natural gas prices in the Shanghai ETS pilot, and the coal prices in the Hubei ETS pilot are found to have significant effects on regional emissions allowances prices in China. Finally, regional energy pricing inefficiency, regional emissions trading market overreaction and their inefficient fundaments may provide major obstacles in reducing the effectiveness of the fossil energy price pass-through to emissions allowances prices in regional ETS pilots.

1. Introduction

China has gradually introduced the regional emissions trading scheme in five cities and three provinces since June 2013 in order to reduce the emissions of greenhouse gases (GHG) linked to climate change through a market-oriented manner. China embarked on an ambitious pathway for launching the unified national emissions trading markets in 2017 on the basis of the joint statement of climate change between the United States and China on November 12, 2014. The Paris Agreement of December 2015 defines that a global stock-take with a five-year cycle will commence in 2023, including mitigation actions and financial commitments. The emissions trading scheme will play a significant role in the future emissions reduction practices in China.

Previous studies empirically examine the dynamics and volatility behavior of emissions allowances prices in the EU's emissions trading scheme (ETS). A complex interplay among policy targets, dynamic technology cost, yearly compliance events and market rules can explain the price dynamics and volatility behavior of emissions allowances [1–3]. Cap-and-trade, hybrid allocation scheme, price caps, banking and borrowing, economic activity, and renewable electricity sources provisions have had obvious impacts on EU emissions allowances prices and traded emissions quantity [4–7]. Sentiment and market attention at the time of the European Parliament decision and long memory accounting for structural breaks are shown to influence both emissions allowances prices and volatility [8,9].

Market practices of the EU's and US's emissions trading scheme confirm that carbon emissions allowances and energy markets have significant linkage effects. Emerging emissions allowances markets attempt to refine the lessons from price forecasting experience in the US SO_2 emissions market; the decisions of consumers and investors in energy markets have significant influences on emissions allowances prices [10]. Previous studies have explored that energy price (oil, coal, natural gas and electricity), unanticipated temperature change, market events and the switching price between gas and coal drive the determinants of emissions allowances prices in the European Union's, the United States' and the Austrian Emissions Trading Scheme [11–17]. Emissions allowances prices have mutually stronger impacts on wholesale electricity price in the asymmetric cost pass-through level [18–20]. Moreover, many studies have investigated that emissions allowances prices are related to fossil fuel price, fuel switching and emissions price caps in

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the emissions trading scheme [21–26]. The main advantage of implementing the emissions trading system is that it ensures essential emissions reduction with lower abatement costs; the economic effect of the emissions trading scheme on energy price depends on the energy market structure [27].

Emissions allowances prices, long-run emissions targets and stabilization mechanisms (emissions price floor and ceiling) can significantly improve the effects of low-carbon energy investment and transition [28–31]. Emissions allowances prices and the volatility of fuel prices have important effects on the competitiveness of renewable energy sources and carbon capture and storage technologies [32,33]. Energy efficiency policy, competitive energy market and emissions trading policies have obvious impacts on electricity and emissions allowances prices [34,35]. Energy resource consumption, financial development, trade openness, energy price and CO_2 emissions exhibit a causal and cointegrated relationship [36–38]. The carbon emissions trading program has the ability to minimize the total abatement cost and improve the economic and environmental benefits [39]. Moreover, renewable energy production, trade openness and financial development can improve CO_2 emissions reductions [40,41]. Accordingly, those studies have found that emissions allowances and energy price have important impacts on low-carbon energy investment, energy transition, and energy efficiency improvement as well as macroeconomic and environmental impacts.

The regional pilots of China's emissions trading schemes (CETS) show marked differences such as the extent of sector coverage, market access threshold and operation in very diverse economic circumstances [42–44]. Accurate emissions reduction allocation and CETS can effectively reduce total abatement cost and promote regional energy savings and CO_2 emissions reductions [45–50]. Appropriate CETS policy design includes emissions caps, emissions reductions allocation mechanism, supplementary policies (penalty and subsidy policies), and energy policy and regional linkage as well as impacts assessment [51–53]. The unified emissions allowances price policy generates a different degree of impacts in improving the environmental quality, decreasing the energy demand and increasing the macroeconomic growth [54,55]. Currently, CETS studies focus on policy design, market differences, and emissions allowances prices policy as well as macroeconomic and environmental impacts.

China's emissions allowances markets have different market characteristics and price determination processes with the EU's and US's ETS markets. Coal, crude oil and liquefied natural gas have experienced a set of significant market pricing policy reforms, including regulatory deregulation and price decentralization, and the asymmetry of Chinese fossil energy and electricity pricing reforms have led to serious conflicts between electricity generation and different fossil fuel supply enterprises for a long time [56,57]. Under Chinese industry policies, coal, crude oil and liquefied natural gas can be transacted with price fluctuations in a free market, while electricity prices remain regulated by the government, thus, market distortions between these two industries are inevitable. The government tends to depress fossil fuel price through administrative power to ensure that high fuel price do not disrupt energy production and consumption. Significant regional differences and location-specific advantages exist in the aspect of regional fuel price differences in China. In several of China's emissions trading scheme pilots, electricity generation, steel, coal and oil mining, cement, and petrochemicals are covered industries; the distortions of fossil fuel and electricity prices cannot reflect the extent full cost, including the production cost pass-through and the resource scarcity, which may also result in excessive energy consumption, environmental deterioration and inefficient resource allocation. Fossil fuel and emissions allowances markets in China are significantly different from the EU and US markets. These major obstacles in China may influence the effectiveness of fossil fuel cost pass-through to emissions allowances prices in the CETS, and improving the fundamentals of regional emissions allowances price and establishing the dynamic linkage relationship between fossil fuel and emissions allowances markets have become important issues in academic research and for policymaking and market participants.

Previous scholars have paid close attention to the fundamentals of pricing emissions allowances and price interactions between EU and US fossil fuel and emissions allowances markets [11,13,14,18–20]. Moreover, China's emissions trading scheme pilots are emerging and heterogeneous markets; regional fossil fuel markets in China exhibit more significantly heterogeneous market characteristics than EU and US fuel markets. Despite the recognized importance of measuring the fundamentals of emissions allowances price in China's emissions trading scheme pilots, the measurement and comparison of the endogenous emissions allowances pricing mechanism in China are still relatively rare. This literature gap prohibits understanding the driving factors of emissions allowances and dynamic linkage effects between emissions allowances and fossil fuel prices in China. This paper focuses on examining the effect of regional energy price changes on regional emissions allowances prices and its main determinant factors under regional CETS pilots using cointegration techniques. The empirical results show that a long-run cointegration relationship exists between the fossil fuel and emissions allowances price during the pilot phase of the CETS, and different fuel prices have different impacts on regional emissions allowances prices. This study extends new insight on regional emissions allowances prices by investigating the transmission of shocks from the primary fossil fuel prices of coal, crude oil and liquefied natural gas in China. It is interesting to determine which primary fuel price is the fundamental factor of determining regional emissions allowances prices.

The empirical results have three beneficial implications for policymakers and market participants. China's emissions allowances markets are not only an important market tool for policymakers to achieve ambitious emissions reduction targets, but also an important choice for market participants to provide new business portfolio opportunities. The results are beneficial for policymakers to clearly grasp emissions allowances pricing formation and undertake policy formulation. Regional emissions trading pilots in China are newly emerging commodity markets, and market participants appear to have little knowledge of the links between fossil fuels and emissions allowances markets in China. The results provide great implication for covered enterprises to modify emissions abatement costs related to emissions reduction actions, to adjust the fossil fuel usage switching and to support efficient investment decisions incorporating into alternative low-carbon technology choices. In the great uncertainty of China's emissions trading markets, estimating the responses of emissions allowances prices to the shocks in main determinants is a necessary skill for market investors to modify investment portfolios, and to directly enhance effective risk management both fuel and emissions allowances assets.

The rest of the article comprises five main sections. Section 2 provides background information and the main regulation policy of regional ETS pilots in China. Section 3 develops the models to estimate the dynamic linkage effects between energy and regional emissions allowances prices. Section 4 collects the data source of emissions allowances and energy prices. The empirical results are reported in Section 5. The empirical results are discussed in Section 6, and finally, main conclusions are drawn in Section 7.

2. Background information of CETS pilot

To implement the Regional Greenhouse Gas Initiative as a market effective mechanism, China has gradually implemented regional pilots of a mandatory emissions trading scheme in the five cities of Beijing, Tianjin, Shanghai, Shenzhen and Chongqing and the three provinces of Hubei, Guangdong and Fujian since June 2013. Several separate ETS pilots, which are cap-and-trade CO_2 emissions programs, have greater divergences in sector coverage, cap setting, fundamental emissions allowances allocation mechanism, and Monitoring, Reporting and Verification (MRV) system.