



Emission trading and carbon market performance in Shenzhen, China



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HIGHLIGHTS

- We assessed the market performance of Shenzhen's emission trading scheme.
- Trading records were used to estimate the degree of volatility and return premium.
- We found that the rate of return was negatively associated with expected risk.
- Kurtosis in trading volume was excessively high and fluctuations were highly concentrated.
- Measures are needed to improve market efficiency and eliminate market distortions.

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ABSTRACT

China has developed its own domestic carbon markets by setting up emission trading schemes. This study addresses concerns about the functioning of these schemes and the financial performance of the Chinese carbon market. It aims to assess an actual outcome of this policy intervention, i.e. trading records, which were used in our analysis to examine a key financial property of the allowance-based market in Shenzhen. In a mature market, assets that incur higher risks are likely to yield higher returns, i.e. a positive relationship. To examine this property, we solicited historical data on the price and trading volume of emission allowances. We statistically estimated the degree of volatility in the Shenzhen market and its relationship with expected return premium. We found that the rate of return was negatively associated with expected risk. This stands at odds with the usual expectation in the financial market and the prediction of asset pricing theory. Also, kurtosis in trading volume was excessively high and its fluctuations were highly concentrated. We discuss these findings in terms of market liquidity and information uncertainties, and offer some policy recommendations. More regulatory attention and economic fixes are needed to improve market efficiency and eliminate sources of market distortions.

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1. Introduction

According to the International Energy Agency [1], carbon emissions from fuel combustion rose from 26,177 Mt in 2004 to 32,190 Mt in 2013 (up 23%). To keep global temperature change below 2 °C relative to pre-industrial levels, substantial cuts in these emissions are required, i.e. globally 40–70 per cent lower in 2050 than in 2010 [2]. The People's Republic of China is the largest carbon emitter, contributing to 28 per cent of the world's total in 2013 [1].

New policy instruments are being introduced in China to strengthen its efforts on greenhouse gas (GHG) mitigation. The past ten years have seen its climate policy preference shifting from

the conventional 'command-and-control' approach towards a market-based one [3–10]. The recent arrival of emission trading schemes (ETS) in seven provinces and municipalities of China marked a watershed in the history of Chinese climate policy [11,12].

Emission trading involves a regulatory body setting an aggregate limit on the level of the regulated emissions, such as GHGs, and issuing permissions to pollute up to that limit. Entities covered by an ETS must hold enough emission allowances for the amount of the emissions they produce. These allowances represent a cost of production and can be exchanged among entities, and therefore have market value. Those entities who can reduce emissions at lower costs sell excess allowances, whereas those who find it more costly to reduce pollution buy allowances. The trading of allowances effectively creates a market institution, commonly known as 'carbon market'.

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Seventeen ETSs are operating in various national or subnational jurisdictions, covering about 8 per cent of annual global GHG emissions (as of August 2015) [13]. The implementation of ETSs by China is regarded as a decisive move towards effective GHG mitigation with global impacts. The seven pilot ETSs in China combined form the world's second largest carbon market, after the European Union (EU) ETS. Indicative estimates provided by World Bank [13, p. 9] suggest that global GHG emissions covered by carbon pricing initiatives will almost double if a national ETS is implemented in China. However, concern and discussion have been raised within China about the shortcomings and timing of nationwide emission trading [14–18].

The use of market-based instruments for controlling GHG emissions is a rather novel attempt in China, which is far from a mature market economy [4,6,7,9,19–21]. Liu and Chen [21] have noted that, for example, China's financial sector has experienced systematic distortions due to excessive state intervention in the market, dominance of state-owned enterprises, and official state control over utility prices. The domestic carbon market in China, predicated upon the pilot ETSs, has reproduced these limitations [18], leading to low market liquidity and efficiency [12,14,22]. These alarming realities might result in poor performance or even the collapse of the Chinese national ETS that is scheduled to commence in or shortly after 2017. Such a possible outcome would pose financial risks to the international carbon market in which China is likely to become a key player and consequently impede global efforts on GHG mitigation. New research is needed to build an empirical basis for understanding and evaluating this major policy intervention in China.

The present research sought further evidence on the functioning of Chinese ETSs, focusing on financial performance. Many studies have addressed their regulatory and management aspects, and come to the conclusion that the pilot designs meet with many challenges [9,21,23]. Only a handful of them, however, have explored the market outcomes of this policy intervention. In fact, few developing countries, namely China and Kazakhstan, have established their own carbon market that is built upon domestic legislation and designated to achieve domestic policy goals, due to their hitherto low capacity and motivation to create one. This results in a lack of knowledge about the performance of carbon markets in these countries.

According to the International Carbon Action Partnership [24], a growing number of developing economies, including Brazil, Chile, Mexico, Thailand, Vietnam, have expressed an interest in setting up a sectoral cap-and-trade system for pricing carbon. Our study can help identify the potential weaknesses of these emerging carbon markets from a financial perspective. Lessons from China can make significant contributions to the scholarly debates about these new developments, given that it is currently the only developing economy having established a domestic ETS (the Kazakhstan ETS is temporarily suspended) [24].

The present research offers new insights by studying an actual outcome (i.e. market transactions) and examining a key financial property of a sub-national carbon market in China. Our objective was to estimate the degree of volatility in this market and its relationship with expected return premium, which can reflect the efficiency of a financial market [25,26]. Trading records provide a statistical basis for assessing the financial maturity of markets. We solicited data on the price and trading volume of emission allowances traded under a pilot ETS since 2013.

Shenzhen, a megacity in South China, was selected as a case study because of its representativeness. The Shenzhen ETS is the first centrally approved scheme launched in China with the most extensive records on allowance price. Moreover, Shenzhen ETS is the first one in China granted a formal legislative basis [21], and regarded as more market-oriented, active, and properly designed

than the other six sub-national carbon markets in China [27, p.19 and p.54]. Therefore, the Shenzhen ETS could act as a role model and offer lessons for other mandatory ETSs in the pipeline. Our inquiry can shed lights on the performance of this carbon market, through which to inform the ongoing debates as to what need to be addressed in order to overcome its imperfections as China and other developing economies pursue their carbon pricing initiatives.

We begin by providing an overview of the economic context in which the Chinese ETSs are situated and a brief description of Shenzhen City. The section that follows explains our main hypothesis and describes how data were collected. The novelty of this research lies in the use of an established econometric technique, known as 'generalized autoregressive conditional heteroscedasticity' (GARCH) model, for analysing Chinese carbon price data. To the best of our knowledge, this is the first attempt to systematically examine these data using GARCH model and compare with the European experiences on this basis. After describing the data collection approach, we provide details about this technique. Results are then presented, and their implications are discussed in the last two sections.

2. Background

2.1. Recent financial market events in China

Emission trading has enabled the financial market to put a price on the right to emit GHGs into the atmosphere [28,29]. The financial market in China began to flourish in the early 1980s, following a progressive policy direction that aimed to 'reform and open-up' the obsolete planned economy. Over-the-counter and negotiated deals dominated this market in the first few years. The secondary market was made active in the early 1990s by the Shanghai Stock Exchange [30] and Shenzhen Stock Exchange (SZSE) established in 19 December 1990 and 3 July 1991, respectively [31]. The stock markets are currently managed by the China Securities Regulatory Commission (CSRC).

The past three decades of financial market management and regulation have proven to be a steep learning curve. The Chinese stock markets in the present day continue to demonstrate many imperfections, including irrational behaviours of individual investors, poorly designed trading mechanisms, ineffective regulations, and flawed policy designs [32]. The combinations of these weaknesses have led to financial breakdowns, the latest one being the stock market crashes in 2015 and 2016. In 12 June 2015, the SSE Composite Index reached its peak at 5178 points, but dramatically fell to a record low at 3373 points in 9 July, i.e. down 35 per cent within one month. During this period, the Growth Enterprise index saw a sharp decline of 43 percent, moving downwards from 4037 points to 2304 points. Before mid-September 2015, more than 1000 stocks experienced a limit-down for 16 times [33]. Individual investors lost confidence and the market ran into a chaos. Many stocks suffered from liquidity issue and could not be sold [34,35]. Managing the massive volatility of financial market has become a pressing issue for Chinese regulators and policymakers.

The most devastating financial policy failure in recent years is related to the 'Circuit Breaker Mechanism' (CBM) introduced by the CSRC. The circuit breaker halts trading if the 'Shanghai Shenzhen CSI 300 Index' drops by a prescribed number of points for a prescribed amount of time. The CBM took effect from 4 January 2016. On its very first day of operation, the Shanghai stock market was put under enormous pressure of short selling and the SSE Composite Index quickly went downwards. In the afternoon (1 pm), the index fell by 5 per cent and 7 per cent in about 20 min, triggering the first two levels of breaker. The market was forced to a temporary closure, and transactions in SSE, SZSE, and

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