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OPINION

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Key challenges for China's carbon emissions trading program

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Abstract
China's national carbon emissions trading program is expected to become the world's largest carbon market and is critical for achieving China's domestic mitigation goals. But China's trading program is likely to face significant challenges, due to its large scale and high complexity. First, the accuracy and credibility of China's emissions data have been widely criticized. There are significant inconsistencies between the national and provincial emissions inventories, and the facility-level data are even less satisfying. Institutional capacities related to the carbon market need to be significantly enhanced to strengthen monitoring, reporting, and verifying capabilities. Second, compared to emissions trading programs in other parts of the world, China's program is likely to face greater market volatility, due to the country's economic structural transition from a manufacturing-based to a service-based economy. Wise cap-setting and allowance allocation methods and proper price containment mechanisms are needed to maintain market stability. And third, China is a market economy with many features of a central planning system, particularly in the energy sector. Large state-owned enterprises (SOEs) do not act as profit-maximizing entities, and their behaviors could undermine the efficiency of the cap-and-trade program. To address these challenges, we provide a series of policy recommendations, including capacity building from central to local levels, wise selection of allowance allocation methods to cope with changing economic realities, and deepening market-oriented reforms in energy sectors and SOEs.

This article is categorized under:
The Carbon Economy and Climate Mitigation > Policies, Instruments, Lifestyles, Behavior

KEYWORDS
carbon market, China, emissions trading, policy design

1 | INTRODUCTION

As the largest CO_2 emitter in the world, China promised to peak its total carbon emissions around 2030 in its nationally determined contribution (NDC). A national emissions trading system (ETS), launched in December 2017 (NDRC, 2017), has been viewed by scholars and policymakers as a key strategy for China to achieve its emissions mitigation goal (Jotzo et al., 2018; D. Zhang, Karplus, Cassisa, & Zhang, 2014). Since China has accounted for about two thirds of global emissions growth over the past decade (IEA, 2018), controlling its carbon emissions would be a significant contribution to the global effort in combating climate change. However, China's program is likely to face significant challenges due to its large scale and high complexity. While some of these challenges are universal to emissions trading programs around the world, such as emissions accounting, allowance allocation, and market volatility (Schmalensee & Stavins, 2017), the others are unique to China due to the country's particular socioeconomic and political realities. Therefore, some researchers have argued that China's ETS needs to incorporate features that differ from other major ETS programs in the world, such as those in European Union and California, in order to cope with the country's specific conditions (Dong, Ma, & Sun, 2016; Duan & Zhou, 2017; Lo, 2013).

To understand the unique challenges China's ETS is likely to face, we review three major categories of existing studies on China’s ETS: empirical analyses of the performance of China's pilot ETS programs in cities and provinces; modeling analyses of the national program; and political economic analyses of the national program. Based on this literature review, the next section examines the evolution of China's ETS from pilots to the national program. The third section identifies the three most critical challenges, namely the lack of institutional capacities, economic structural transitions, and strong state control in energy sectors. The fourth section presents our policy recommendations. Finally, we offer concluding comments in the fifth section.

2 | EVOLUTION OF CHINA's ETS FROM PILOTS TO NATIONAL PROGRAM

China has chosen an ETS as one of the key approaches to reducing greenhouse gas emissions (Z. Zhang, 2015). Researchers have identified both international and domestic factors that have motivated China to establish ETS. First, as the world's largest CO2 emitter and an emerging geopolitical power, China has begun to shown an increasing willingness to shoulder responsibility for climate change mitigation (Lee & Wang, 2017; Lo, 2015). Since 2013, it made joint commitments for emissions reduction and clean energy development with the United States, the European Union, and several developing countries (Hilton & Kerr, 2017). Advocated as an effective and efficient policy instrument, ETS has been widely studied and implemented in other countries for more than three decades. Subsequently, China has been willing to follow the example set by European Union emissions trading system (EU-ETS) and California, and to learn lessons from their experiences (Schmalensee & Stavins, 2017). Second, China has been facing a bottleneck in economic and social development in recent years, due to excess production capacity in low-end industries, and high environmental costs (Guan, Peters, Weber, & Hubacek, 2009; Lee & Wang, 2017; Qi & Wu, 2013; Z. Zhang, 2010). A national ETS is expected to gradually drive energy-inefficient factories out of business and incentivize the application of more efficient technologies, and to help China to transition from a manufacturing economy to a service economy (Lo, 2013; Springer, Evans, Lin, & Roland-Holst, 2019; H. Zhang, Cao, & Zhang, 2017). And lastly, a national ETS will help change China's coal-dominated energy structure, bringing collateral health benefits through the reduction of severe air pollution in urban areas (Li et al., 2018; Peng, Yang, Wagner, & Mauzerall, 2017; Q. Zhang, He, & Huo, 2012). Coal currently accounts for approximately 70% of China's energy supply and it generates more CO_2, SO_2, and other pollutants per energy unit than other energy sources (Huang, Hu, Chen, & Zhang, 2017; F. Liu et al., 2015; Z. Zhang, 2010). Model simulations (Dai, Xie, Liu, & Masui, 2018; H. Zhang et al., 2017) show that after implementing the national ETS, the cost of using fossil fuels will increase significantly, and renewable energy sources will be more economically competitive and their market shares will expand. The development of clean technologies and emissions capture and storage will also be incentivized in the long term.

In 2011, China's Twelfth Five-Year Plan (Chapter 21) stated that China should “actively cope with global climate change…and gradually establish carbon emissions trading systems”. In the same year, the National Development and Reform Commission (NDRC) approved a plan to build seven emissions trading pilot programs in five major cities (Beijing, Shanghai, Tianjin, Chongqing, and Shenzhen) and two provinces (Guangdong and Hubei). The seven ETS pilots were initiated in 2013. In principle, the NDRC supervises the design and implementation of all the ETS pilots, but in practice, the NDRC delegates rule-making authority to provincial and municipal governments. Since the purpose of the seven pilot programs is to explore different designing features and accumulate experience for the national program (Dong et al., 2016; Pang & Duan, 2016), the pilot programs have different implementation plans, legislations, and trading rules. The key features of ETS, including cap-setting, coverage of industries, allocation of allowances, MVR (measurable, verifiable, and reportable) rules, and tradable products, therefore vary across pilots (Pang & Duan, 2016) (Table 1).

The ETS pilot programs are accompanied by voluntary Greenhouse Gas (GHG) emissions offsetting programs. As a non-Annex I country in the Kyoto Protocol, China issued guidelines for clean development mechanism (CDM) projects in 2005 and became a major CDM credits provider (Z. Zhang, 2006). In 2012, in preparation for ETS pilots, the NDRC published “Interim Measures on Voluntary GHG Emissions Reduction Trading,” and CDM projects were replaced by the native Chinese Certified Emission Reductions programs (CCER). Trading of CCER is usually restricted to 5–10% of the total emissions in the ETS pilot programs, and some programs have further restrictions on the use of CCER credits, such as the exclusion of

TABLE 1 Design features of the seven pilot emissions trading system (ETS) programs

	Cap	Coverage	Allocation	Tradable products
Beijing	About 55 Mt CO2	Power, heating, cement, petrochemical, other industries, and services	Free allocation, combining grandfathering and benchmarking	BJEA[a], CCER[b], energy savings, carbon sink
Tianjin	About 160 Mt CO2	Iron and steel, chemical, power and heating, petrochemical, oil and gas drilling	Free allocation, combining grandfathering and benchmarking	TJEA, CCER
Shanghai	About 150 Mt CO2	Iron and steel, petrochemical, chemical, power and heating, nonferrous, building materials, aviation, airport, ports, railways, hotels, commercial and retails, and finance	Mostly free allocation, combining grandfathering and benchmarking; 7,220 tons of allowances were auctioned by June 30, 2014	SHEA, CCER
Guangdong	About 388 Mt CO2	Power, cement, iron and steel, petrochemical	Mostly free allocation, combining grandfathering and benchmarking; Auctioning: 3% in 2013; 5% in power sector and 3% in other sectors in 2014)	GDEA, CCER
Shenzhen	About 30 Mt CO2	26 subsectors (manufacturing industries) public and commercial buildings	Free allocation: Most industries; Manufacturing sector: Competitive gaming Construction sector: Benchmarking Auction: 75,000 tons (June 6, 2014)	SZEA, CCER
Hubei	324 Mt CO2	Power, iron and steel, cement, chemical, petrochemical, cars and equipment manufacturing, nonferrous	Mostly free allocation, combining grandfathering and benchmarking; Auction: 30% allowance for auction; auctioned 2 million tons on March 31, 2014	HBEA, CCER
Chongqing	130 Mt CO2	Power, metallurgy, chemical industry, and other industries	Free allocation: Combination of cap-trade and competitive gaming	CQEA-1, CCER

[a]BJEA: BJ stands for Beijing, EA stands for emissions allowances. Similarly, TJEA, SHEA, GDEA, SZEA, HBEA, and CQEA represent emissions allowances in Tianjin, Shanghai, Guangdong, Shenzhen, Hubei, and Chongqing, respectively.
[b]CCER represents Chinese Certified Emission Reductions.

CCER obtained from hydropower projects (D. Zhang et al., 2014). Even though the pilot programs created separated markets and allowances are not recognized by each other, the pilot markets are actually indirectly linked by the trading of CCER (Munnings, Morgenstern, Wang, & Liu, 2014).

The seven ETS pilots, covering major emission sectors and enterprises, have played a modest role in reaching local carbon intensity targets (Munnings et al., 2014). The operation of the programs has helped build technical foundations and institutional capacities, and also shaped the first carbon markets and revealed market-driven carbon prices in China. By May 2016, the cumulative market value of traded allowances in the seven pilots reached 1,561.12 million yuan, and their transaction volumes reached 61.25 million ton (Chang, Pei, Zhang, & Wu, 2017). Companies' awareness and capacity in emissions trading was improved. Through a survey conducted in companies participating in the ETS pilots, Yang et al found that companies' attitudes toward the ETS were positively influenced by government policies and estimated economic benefits (Yang, Li, & Zhang, 2016). The pilot programs also have the potential to bring cobenefits in air pollution reduction, according to a modeling study conducted in the Guangdong pilot (Cheng, Dai, Wang, Zhao, & Masui, 2015). But the pilot programs also revealed multiple problems. Liu et al. pointed out that market segmentation, imperfect trading mechanisms, and lack of legal framework seriously affected the effectiveness of the pilot programs (Liu, Chen, Zhao, & Zhao, 2015). Yu and Lo found that regulatory standards and official data on emissions were incomplete and inconsistent, and noncompliance was widespread (Yu &

Lo, 2014). Deng et al found that the measuring, reporting, and verification (MRV) and compliance rules were not fully implemented (Deng, Li, Pang, & Duan, 2018).

The lessons from the seven pilot programs, both positive and negative, will be used in the development of the national ETS. Most importantly, the national program will need to reconcile the different rules of the pilots, help the pilot regions transition to the national program, and correct the major problems in the pilots, including insufficient legal foundation, unclear market trading rules, and weak implementation, compliance, and punishments. Launched in December, 2017, the first phase of the national program focused on building a national emissions reporting framework, followed by a "trial run" that initially will cover the power sector, and the later phases will expand the coverage to include other carbon-intensive sectors (Jotzo et al., 2018). However, so far the design details of the national program are still unclear to the public, except for a few general principles, such as the principle that it will cover facilities with annual energy consumption of more than 10,000 ton of coal equivalent, and that the majority of allowances to be given for free based on subsectoral performance standards (Jotzo et al., 2018). Once fully established, the national ETS will have the potential to become a key feature of China's climate governance, and the primary policy instrument of its emission reduction goals (Jotzo et al., 2018; L. Liu, Chen, et al., 2015). Furthermore, if it is properly designed and implemented, it could be the most cost-effective policy option, according to the results of modeling studies conducted by many researchers (Cui, Fan, Zhu, & Bi, 2014; Fan, Wu, Xia, & Liu, 2016; Hübler, Voigt, & Löschel, 2014; Mu, Evans, Wang, & Cai, 2018; K. Wang, Wei, & Huang, 2016). Yet, on the other hand, the success of an ETS program requires the appropriate institutional context at both macro- and microlevels. Well-functioning market mechanisms, long-term policy credibility, and strict monitoring and enforcement are all crucial to the alignment of enterprise interests with the broader public-oriented goal of ETS. In this sense, China is expected to face significant challenges in the development of a national ETS, as will be discussed in the following section.

3 | THE MAJOR CHALLENGES

China has an advantage in learning lessons from the experience of existing ETS programs in other countries. The experience of the EU-ETS has shown that over-allocating allowances could lead to a collapse of carbon prices and undermine the effectiveness of the carbon market (Branger, Lecuyer, & Quirion, 2015; Laing, Sato, Grubb, & Comberti, 2014). California's experience shows that a combination of allocation methods, starting with free allocation and gradually increasing the use of auctioning, could be both a politically feasible and environmentally sound approach (Schmalensee & Stavins, 2017). And ETS programs around the world show the importance of having consistent and continuous policies in order to provide stable market expectations and confidence (Meckling, 2014). Besides these universal challenges, we argue that China also faces challenges different from other countries and needs to find new solutions. Experience of the pilots revealed the lack of institutional capacities and credible emissions inventories (Deng et al., 2018). Economic structural transitioning creates great fluctuation in energy consumption (Springer et al., 2019). And as a market economy with many remaining features from the central planning era, China's economy has long suffered from excessive government intervention and incomplete regulatory infrastructure (Lo, 2016). In addition, the presence of powerful state-owned enterprises (SOEs) and the absence of a merit-based dispatch system in the electricity market (Kahrl, Williams, Ding, & Hu, 2011; Kahrl, Williams, & Hu, 2013), all threaten the effectiveness of the national ETS. We identify the following three issues that we regard as the most critical challenges, and provide our policy recommendations in the next section.

First, a cap-and-trade program is a highly complex artificial market for carbon emissions that requires reliable emissions data, clearly defined market rules, and strict enforcement, all of which require advanced institutional capacities. Particularly, accurate facility-level emissions data is a prerequisite for allowances transactions and compliance. But the accuracy and credibility of China's emissions data have been widely criticized (Guan, Liu, Geng, Lindner, & Hubacek, 2012). There are significant inconsistencies between the national and provincial emissions inventories (Z. Liu et al., 2015), and the facility-level data are even less satisfying. An important reason for weak data foundation is inadequate institutional capacities and lack of legal support. The pilot programs are managed by relatively lower-ranked government agencies, which lack sufficient authority and are understaffed for market design and management (Deng et al., 2018; Yu & Lo, 2014). Most of the pilots are not backed by legislation passed in the People's Congress, but by ad hoc government guidelines (Munnings et al., 2014). As a result, the program managers found it difficult to mandate the firms to report their actual emissions, and the firms found the cost of violation is usually lower than the cost of compliance. Therefore, to make the national program work, institutional capacities related to the carbon market need to be significantly enhanced from central to local levels.

Second, compared to emissions trading programs in other parts of the world, China's program is likely to face greater market volatility, due to the country's structural transition from a manufacturing economy to a service economy. International experiences have shown that changes in market conditions could cause significant volatility in carbon markets (Schmalensee & Stavins, 2017). In California, regional greenhouse gas initiative (RGGI), and the EU-ETS, the proportions of heavy industries are small, while other sources of emissions are relatively stable. Even so, after the 2009 financial crisis, carbon prices in RGGI and EU-ETS fell sharply and the markets almost collapsed (Hibbard, Okie, Tierney, & Darling, 2015; Laing et al., 2014). China's steel, cement, and other high-emission industries in recent years have been affected significantly by economic fluctuations, so the demand for allowances will likely be very volatile. In addition, in the context of economic restructuring, some heavy industries could receive too many allowances as they are declining, which could turn the cap-and-trade program into a form of subsidies to these industries and obstruct China's low-carbon transition. Thus, the drastic and uncertain changes in China's economy will significantly complicate the design and management of the program.

And third, emissions trading is a market-based policy tool, which is most effective when there are well-functioning market mechanisms. But China is a market economy with many remaining features of a central planning system (*P. Wang*, Liu, & Wu, 2018). In particular, the SOEs, many of which evolved from former central government agencies, have nearly monopolistic control over energy supply and strong influence on national policymaking. Since the SOEs do not act as conventional profit-maximizing entities, their behaviors could undermine the efficiency of the cap-and-trade program. Moreover, China's electricity market is highly regulated, with the generation quotas and prices predetermined by the government (Kahrl et al., 2013). Thus, the electricity sector, the largest emissions source, will not have timely responses to the changing carbon price, and the "test run" of the national ETS, which covers only electricity sector, would largely be a tradable performance standard system. One of the distinctive features of China's ETS pilots is that they cover both direct emissions, such as emissions from power plants, and indirect emissions, such as emissions embodied in the consumption of heat and electricity, in order to solve the issue of fixed electricity price (Pang & Duan, 2016). But this method causes double counting for some emission sources and could distort the price signal. People hope a market-oriented reform to be conducted in the power sector, so that the national program would no longer need to cover the indirect emissions, but the likelihood is small in the near future (Zeng, Yang, Wang, & Sun, 2016). To ensure the effectiveness of the emissions trading program, China will need to deepen its market-oriented reforms for SOEs, particularly in energy and electricity sectors (Gallagher, Zhang, Orvis, Rissman, & Liu, 2019).

4 | POLICY RECOMMENDATIONS

To tackle the above challenges, we provide the following policy recommendations, based on China's specific socioeconomic and political contexts.

First, institutional capacities need to be significantly enhanced from central to local levels. The national cap-and-trade program needs to be managed and coordinated in high-level government agencies, and be backed by national legislation. Unlike an ordinary environmental regulation that impacts only a small fraction of the economy, an emissions trading program will have significant economy-wide effects. Therefore, the State Council needs to give carbon market managers enough authority to coordinate multiple ministries and provinces and develop a top-level regulatory system. The current ad hoc government guidelines are not sufficient to ensure implementation and enforcement of the program, so formal climate change laws need to be passed by the National People's Congress to provide firm legal support. Financial and human resources should be provided to establish facility-level emissions databases, reliable methodologies for MRV, and training of a large number of professional practitioners in supervision, trade, and third-party verification.

Second, China's profound economic structural change creates significant uncertainties in carbon emissions from various industrial sectors, which requires the cap-and-trade program to be robust enough to cope with changing economic realities. The choice of methods to allocate emission allowances becomes critical. Studies have shown that auctioning is the best way to distribute allowances to the most needed firms and to set the right economic incentives for emissions reduction (Stavins, 2008). But auctioning has high initial costs and could encounter significant political resistance. Therefore, in practice, cap-and-trade programs usually auction just 5–10% of allowances initially, and give out most allowances free of charge (California Air Resources Board, 2015; European Commission, 2013). If China is to distribute free allowances to firms based on their historical emissions, the declining heavy industries will get excessive allowances that they could sell for profit. Thus, technology-based benchmarking, or a frequently updated output-based method should be adopted as much as possible in the allocation process in order to adapt to changing economic conditions. High uncertainties also mean that certain price containment mechanisms need to be put into place to maintain market stability. A price ceiling, at which the government releases more allowances, and a price floor, at which the government buys back allowances, should be considered in China's program.

And last, deep reforms are needed in energy sectors and SOEs to create a favorable market environment. The effectiveness of the emissions trading program could be greatly undermined by the nonmarket factors in Chinese economy, particularly the generation quotas and fixed prices in the electricity sector, and the market power of SOEs. Currently, both the emissions trading program and electricity market reform are the highlights of national efforts to "deepen the comprehensive reforms" and "let the market play a fundamental role in resource allocation." It is important that the two initiatives are pushed forward shoulder-to-shoulder. The electricity generation quotas need to be replaced by a competitive wholesale market, and electricity prices need to be determined by the market, so that carbon prices can be reflected in a timely manner in electricity prices. The management of SOEs also needs to be changed to create a fair competitive market for both SOEs and privately-owned enterprises.

5 | CONCLUSION

The national emissions trading program is regarded as a cornerstone of China's climate policy outlined in the 13th Five-year Plan (2016–2020), the highest level government plan in the country. But its effectiveness will be contingent on the right institutional settings at both macro- and micro-levels. Well-functioning market mechanisms are crucial to align enterprises' interests with the goals of the program. Firm legal foundation, carefully designed rules, and capable agencies and practitioners are all critical for the success of the program. It will be difficult for China to get all the factors right in the beginning. But if China starts to move toward the right direction now, its emissions trading program can evolve gradually and show great potential in facilitating a low-carbon transition in the long term. This will be good news for China and for the world in combatting climate change.

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CONFLICT OF INTEREST

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