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China's New National Carbon Market

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Review
This working paper has not undergone a formal review process. It is intended to stimulate discussion and inform debate on emerging issues.

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Summary

On December 19, 2017, China announced the official start of its national emissions trading system (ETS) construction program. When fully implemented, this program could more than double the volume of worldwide carbon dioxide emissions covered by either tax or tradable permit policy. Many of program's design features reflect those of China's pilot programs but widely differ from those of emissions trading programs in the United States and Europe. For that reason, the workings of Chinese national carbon market are both intriguing and unfamiliar to those experienced with western markets. This paper explains the design of China's new carbon market, contrasts it with western markets, and highlights possible implications. It also presents research questions raised by the design.

INTRODUCTION

Since the introduction of the European Emission Trading System (ETS), carbon pricing programs have grown from covering roughly 5% of global emissions in 2005 to nearly 15% in 2017 (Oppermann et al. 2017). With the introduction of China's carbon trading program in 2018, this number could double. Carbon pricing, through either tradable emissions allowances or emissions taxes, transparently equalizes the economic incentive to reduce emissions and is synonymous with conditions for least-cost regulation (Schmalensee and Stavins 2017).

Nevertheless, design choices matter. At the highest level, jurisdictions choose what to include and exclude from a trading program as well as determine the program's overall stringency (as captured by the ultimate carbon price). Beyond these considerations, there are important choices, including allocation and revenue, emissions or price certainty, offsets, competitiveness mechanisms, and the use of overlapping policies. These and other choices have important consequences for the volume of emissions reductions, the overall program cost, and the bearers of that cost.

This paper explores key design choices in China's new national carbon market. It provides some background for the context of China's policy. Why address climate change and why use carbon markets to do so? It then catalogs some of the important features, particularly, coverage and allocation. Finally, it dives into the allocation design, which essentially creates a multi-sector tradable performance standard. This design has consequences for product prices, cost-effectiveness, indirect electricity emissions, leakage and competitiveness, and cost management tools.

THE CHINA CONTEXT

China's 2015 climate pledge or Nationally Determined Contribution (NDC) under the Paris Agreement, the global accord to limit global warming, includes meeting, by or before 2030, three goals: (1) peaking the country's carbon dioxide emissions; (2) lowering those emissions per unit of GDP, that is, reducing the economy's carbon intensity 60%–65% from the 2005 level; and (3) increasing the share of non-fossil fuels (renewables and nuclear) in primary energy consumption to 20%. For its 13th Five Year Plan (2016–2020), the Chinese central government has set, and the Chinese Congress has ratified, two domestic legally binding targets addressing China's climate pledges. One is to decrease the economy's carbon intensity by 18% relative to 2015. The other is to increase the share of non-fossil fuels in primary energy supply to 15% by 2020. China's international commitments and domestic targets for addressing climate change mirrors President Xi Jinping's new development paradigm that attaches great importance to green development and climate change mitigation.

Over past decade, China has adopted subsidy programs for energy efficiency investment projects, energy performance standards, and feed-in tariffs for renewable electricity as the primary policy instruments for low-carbon development. The Ministry of Finance stopped the energy efficiency subsidy program in 2013. The implementation of energy performance standards is largely voluntary, and there are no punishments for non-compliance. The feed-in tariff can only address renewable electricity supply issues. These policies would appear insufficient to meet China's climate pledge and achieve the domestic legally binding targets for low-carbon development.

At the same time, the Chinese government has been attaching increasing importance to market-based policies to achieve environmental goals. For almost a decade, the government has considered introducing such a policy instrument to control carbon dioxide emissions. This process involved a debate on whether China should introduce an emissions trading system (ETS) or a carbon tax.

The recent decision to implement an emissions trading system over a carbon tax reflects a number of factors. A tax would fall under the purview of the Ministry of Finance. The National Development and Reform Commission (NDRC) would oversee an emissions trading system and also favors more a certain emissions reduction than a certain carbon price. The NDRC is the primary government agency in charge of major national initiatives. Second, now it is politically impossible to introduce a reasonably high carbon tax in China, whereas a reasonably ambitious emissions trading system may be possible. A low carbon tax may be even less effective in China because the electricity market, oil market, and natural gas market are heavily regulated. Third, more than 80% of China's carbon dioxide emissions comes from the energy supply sector and the manufacturing sector, and approximately half of those emissions occur in just 6,000 companies. The NDRC does not view this kind of management activity as a significant challenge. The state owns a large part of these companies, which have significant expertise and experience in energy management and which are used to complying with government mandates. Finally, the three-year-old ETS pilot programs in five cities and two provinces have provided ETS experience and momentum.

CARBON MARKET DESIGN

Alongside the ETS announcement, the NDRC released its Guidelines of National Carbon Emissions Trading System (ETS) Construction, which was approved by the State Council. The document presents the guiding principles and steps of China's national ETS construction, which will involve three phases. The first phase ("infrastructure construction") will last approximately one year and focus on the construction of a national monitoring, reporting, and verification (MRV) system, a national registration to track allowance ownership, and a national platform for emissions trading. The second phase ("system test") will last another year and involve a trial run with only one sector, electric power generation, to test the design of the national ETS, including the system's allocation, trading, registry, and compliance protocols, without the full legal, regulatory burden in place. The third phase ("development and improvement") will mark the beginning of the full ETS regime with the power generation sector and will gradually extend to other sectors.

Many program elements are not detailed in the document, particularly the allowance allocation protocol. The expected design is based in part on the recent document and in part on experience with an allowance allocation trial. This trial was conducted with three sectors (power generation, cement, and aluminum) and was organized by the NDRC in two provinces (Jiangsu and Sichuan) in May 2017. It provides a likely blueprint for the eventual allowance allocation.

Coverage and Threshold

According to the information released by the NDRC, China's national emissions trading system will cover eight sectors: electricity (including power generation, power and heat cogeneration, and grid distribution), building materials, iron and steel, non-ferrous metal processing, petroleum refining, chemicals, pulp and paper, and aviation. Companies with an annual energy consumption of more than 10,000 tons of coal equivalent, or roughly 26,000 tons of carbon dioxide, in the eight sectors must participant in the emissions trading system.[1] As a result, that system will regulate approximately 6,000 enterprises, covering one half of China's total carbon dioxide emissions.

Like the seven ETS pilot programs, China's national emissions trading system will regulate only carbon dioxide emissions, not other greenhouse gases (GHGs). These emissions account for 83.2% of China's total GHG emissions.

Output-based Allocation

Most emissions allowances will be distributed freely by the government in the first phase of China's national emissions trading system. Free allowance allocation has been widely used in the first phase of most of the world's emissions trading systems. So far it is unclear when an allowances auction will be introduced and how many allowances might be auctioned. The primary free allocation method is based on sectoral benchmarks or performance standards. This method is similar to the output-based allocation proposed for trade-exposed industries in 2009 U.S. legislation (Fisher and Fox 2011; U.S. EPA 2009). In that context, output-based allocation was used to allocate some portion of an overall, larger, and fixed cap. Here, it is used in part to set the cap, which will vary on the basis of production levels. In that sense, it is more analogous to multi-sector performance, intensity standards, or rate-based regulation.

To avoid an ad hoc approach to fairness issues, China's ETS pilot programs changed from a mass-based approach to an output-based system as soon as the capacity and data for benchmark formulation were in place. In turn, the national emissions trading system will adopt that system.

The output-based allocation approach largely comes from the experience of the ETS pilot programs. At the beginning, all the programs intended to adopt a mass-based, "grandfathering" allowance allocation approach based on past emissions, at least in part because they lacked the additional data and technical capacity needed to set appropriate benchmarks. But the provincial/municipal development and reform commissions (DRCs) found that it hard to formulate a "reasonable and fair" grandfathering option.

[1] For comparison, the U.S. Clean Power Plan would regulate power plants above 25MW, which is closer to 75,000 tons or more, depending on the fuel and operating frequency.

Why the difficulty? First, electricity and district heat prices are controlled by the government (mostly the Central Government). Therefore, the electricity and district heat generators are not able to pass down increased costs to heat and electricity users. Second, growth in demand for electricity and heat remains relatively high in almost all regions of China, a situation different from that in most developed countries. Therefore, electricity and district heat companies requested the DRCs give them additional allowances equal to those associated with increased uses of electricity and heat. Third, in the manufacturing sector, many companies are experiencing production capacity expansion but have increased their carbon emissions performance due to adoption of energy efficiency technology. The grandfathering allocation approach would result in an allowance shortage in those companies, punishing those with low emissions rates but high growth. Finally, there are other situations in which companies are experiencing production capacity reduction (such as in steel and cement sectors where there is considerable over-capacity). In this case, the mass-based approach will lead to windfall profits.

To address these fairness issues under a grandfathering approach based on past emissions, the DRCs would necessarily have to make adjustments for these companies. Such ad hoc adjustments are not only costly for DRCs but also increase opportunities for corruption. As a result, all the ETS pilot programs changed from a mass-based approach to an output-based system as soon as the capacity and data for benchmark formulation were in place. In turn, the national emissions trading system will adopt that system.

In practice, the allocation approach is described in documents used for the allowance allocation trials conducted by the NDRC in May 2017 for the three sectors (power generation, cement, and aluminum) in Sichuan Province and Jiangsu Province. The allowance allocation a that a generation installation of a power generation company receives can be mathematically represented by

$$\mathrm{a} = bq \qquad (1)$$

where b is the benchmarking carbon dioxide emissions per unit of electricity output for the generation technology category to which the generation installation belongs, ton/MWh; and q is the actual electricity output for the compliance year. The benchmarking emission performance b is set by the NDRC and represents a performance between the average performance and the best performance of the generation technology category. There are different generation technology categories for the power generation sector that receive different benchmarks (see "Subcategorization" section below). Over time, the number of the categories will be reduced, creating incentives for the phasing out of high-emitting technologies.

The allowance allocation process involves two steps. At the start of the compliance year, the power generation installation will receive an initial allocation, a_0, equal to its output from the previous year, q_0, multiplied by the benchmark performance, b, of its generation technology category and an "initial allocation factor," ρ. That is,

$$\mathrm{a}_0 = \rho b q_0 \qquad (2)$$

In a designated month after the end of the compliance year when final production data, q, are available, the generation installation will receive the quantity of additional allowances indicated by the following formula:

$$\mathrm{aa} = qb - \rho q_0 b \qquad (3)$$

Notably, aa can be negative. In such a case, the company should give back the allowances over allocated by the government. The quantity of the allowances for a power generation company as a whole is the sum of the allowances allocation for each installation owned by the company. The same approach was used for the allowance allocations of the cement sector and the aluminum sector in the allowance allocation trials.

Indirect Emissions from Electricity and District Heating

Once the program expands beyond the electricity sector, a very important feature of China's emissions trading system is the handling of indirect emissions from electricity consumption. In particular, enterprises are responsible not only for mitigating on-site carbon dioxide emissions, or direct emissions, but also the carbon dioxide emissions associated with their consumption of electricity and heat, or indirect emissions. This provision is partly attributable to price policies in China. The primary electricity and heat tariffs are decided by the Central Government and local governments rather than the market. Even with market prices, however, the output-based allocation mechanism does not incentivize conservation of downstream carbon-intensive products, like heat and electricity.

More than 50% of China's total coal is burned for electricity and heat production, and more than 70% of China's total electricity and heat are used by the manufacturing sectors. In this context, it is very important to make sure that the electricity and heat users can take the sufficient responsibility for the CO_2 emissions embodied in electricity and heat under the ETS as they should.

Subcategorization

As noted above, allocation within sectors can be differentiated by technology. In the allowance allocation trial organized by the NDRC, there are 11 performance standards for the power generation sector. The primary subcategories are

- Ultra-supercritical coal-fired power generation units with a capacity of 1,000MW
- Ultra-supercritical coal-fired power generation units with a capacity of 600MW
- Supercritical coal-fired power generation units with a capacity of 600MW
- Supercritical coal-fired power generation units with a capacity of 300MW
- Subcritical coal-fired power generation units with a capacity of 600MW
- Subcritical coal-fired power generation units with a capacity of 300MW
- Other types of coal-fired power generation units with a capacity of 300MW or less
- F-class gas-fired power generation units
- Other types of gas-fired power generation units.

The primary purpose for the subcategorization is to avoid the immediate bankruptcy of many of the power companies with backward technology at the beginning of the national ETS construction. It is largely viewed as a political compromise that the NDRC has to make for the power sector in order to secure a smooth launching of the national emissions trading system. Subcategorization, however, can lead to less cost-effective outcomes because it tends to focus incentives on efficiency improvements within technology subcategories, rather than on improving choices across subcategories, as discussed below.

Provincial Government Role

As indicated by the above-noted NDRC document, Guidelines of Cap Setting and Allowance Allocation, provinces are allowed to increase the stringency of the sectoral benchmarks. That is, the parameter b in equations (1) to (3) can be set lower by provincial governments. Because these governments face compliance with the domestic law on carbon intensity, for example, they may choose to use the national emissions trading system as a tool to meet that objective. According to a draft of the Guidelines of Cap Setting and Allowance Allocation circulated for comments and suggestions, the provincial governments of the regions where there are serious air pollution and other environmental problems can also auction a portion of the allowances.

MULTI-SECTOR TRADABLE PERFORMANCE STANDARD

One of the most interesting features of China's national emissions trading system is that it is effectively a multi-sector tradable performance standard. As in a cap-and-trade program, emitters of carbon dioxide face compliance obligations based on their volume of emissions. However, the realized allowance allocation each year for a given emissions source equals a sector-specific benchmark emissions rate multiplied by that source's actual production level in that year. In aggregate, the emissions limit varies with production. As noted above, the program begins in a single sector, electricity, and is slated to expand. Even within the power sector, there are multiple subcategories or subsectors, the significance of which is explained below with reference to other cap-and-trade programs.

Single-Sector Tradable Performance Standards

There are many examples of single-sector tradable performance standards, most notably the U.S. lead phasedown (Hahn and Hester 1989; Kerr and Newell 2003), California's Low Carbon Fuel Standard (Holland, Hughes, and Knittel 2009), and Corporate Average Fuel Economy (Rubin, Leiby, and Greene 2009). Renewable portfolio standards (Cox and Esterly 2016) and clean energy standards (Aldy 2011) have a similar design with obligations (rather than credit) assigned to production generally and credit (rather than obligations) assigned to renewable generation. Like tradable performance standards for pollution, these crediting standards for clean energy scale with production.

Single-sector tradable performance standards have many similarities with cap-and-trade programs. Importantly, they establish a uniform emissions price and encourage cost-effective mitigation within the sector. Companies with excess credits can sell them, while those in need can buy them. The credit price will then rise or fall until supply equals demand, and the performance standard is met on average. In equilibrium, firms that can reduce emissions more cheaply than the observed price have an incentive to do so, whereas those facing more expensive mitigation do not. Moreover, production can also shift from dirtier to cleaner producers if that is a cost-effective mitigation strategy for the sector as a whole. Hence the cost-effectiveness condition is met within the sector.

The one big difference between cap-and-trade and tradable performance standards is that tradable performance standards tend to have smaller effects on product prices (Boom and Dijkstra). Whereas cap-and-trade policies put a positive price on all carbon dioxide emissions, tradable performance standards put a price only on carbon dioxide emissions above the standard. This strategy leads to smaller increases in marginal production costs and, in a market economy, product prices. If relatively clean producers are the marginal cost producers, it can even lead to a decline in product prices in the short run (Fischer 2010; Fischer and Newell 2008). For example, a tradable performance standard in the power sector will lead to smaller price increases in electricity (Burtraw et al. 2014).

For this reason, tradable performance standards can be preferred when there are concerns about impacts on downstream product users. Output-based allocations, for example, are quite similar to tradable performance standards in their allocation of permits on the basis of production levels (though they operate inside of an overall cap-and-trade scheme). They are frequently proposed as a way to mitigate emissions leakage and competitive impacts (U.S. EPA, OAR).

> **Output-based allocations—allocation of permits on the basis of production levels—are frequently proposed as a way to mitigate emissions leakage and competitive impacts. The downside to this approach is that it discourages cost-effective mitigation across sectors.**

The downside to this approach is that it discourages cost-effective mitigation across sectors. Cap-and-trade programs raise the price of products to reflect their associated emissions. For example, electricity prices rise to reflect the carbon dioxide emissions of marginal electricity production. The price increase leads users to conserve electricity on the basis of its carbon emissions and, indeed, to balance mitigation within electricity productions with efforts to reduce electricity consumption. By having a smaller effect on product prices, tradable performance standards fail to achieve cost-effectiveness in this dimension.

Subcategorization and Multiple Sectors

Subcategorization increases the risk of significant deviations from cost-effectiveness. By assigning different performance standards to different producers on the basis of fuel or production technique, cleaner production is no longer incentivized to the same degree. In fact, if those subcategories with a higher emissions rate can mitigate cheaply, subcategorization can even raise the emissions rate of the sector as a whole. That is, the emissions rate of the sector as a whole is the average of the subcategories. If production shifts to higher-emitting subcategories, the emissions rate can go up even as the emissions rate in each subcategory declines.

The Clean Power Plan (CPP) rule in the United States attempted to deal with this problem by creating special "gas-shift emission reduction credits." Under the rule, natural gas combined cycle (NGCC) plants faced one standard and steam plants another, higher emissions rate standard. To encourage production to shift to NGCC plants, rather than stay the same or even shift away from NGCC plants, those plants earned extra "gas-shift" credits (Adair and DeMeester 2015).

A similar but not so obviously perverse outcome can occur with multi-sector tradable performance standards. Some sectors with relatively easy-to-achieve standards can be effectively subsidized by other sectors with relatively stringent standards. It is partly this possibility that has fueled concerns that output-based allocation could lead to thinly veiled attempts at export subsidies (Haites 2003). Like subcategorization, such allocation can also lead to higher emissions if the sectors with easy-to-achieve standards have higher emissions per dollar (or yuan) of added value. That is, the emissions intensity of GDP can be increased even as performance standards in each sector are declining.

How does a multi-sector tradable performance standard avoid significantly subsidizing some sectors, possibly even increasing emissions? This topic is an interesting one for further research, but here we speculate on a few possibilities. One solution would be to set more challenging (e.g., more-expensive-to-comply-with) standards for dirtier subcategories and sectors (per dollar of value added), relative to cleaner subcategories and sectors, so dirtier sectors are unambiguously net buyers. Alternatively, as in the Clean Power Plan, a program could assign additional credits to cleaner sectors. Both approaches effectively take a standard that differentiates among sectors and move back closer to a single standard. Under a single standard (e.g., emissions per dollar of added value), it is clear that the aggregate emissions rate (per dollar of GDP) is declining.

How does a multi-sector tradable performance standard avoid significantly subsidizing some sectors, possibly even increasing emissions? There are a few possibilities.

Rather than moving toward harmonization, a program could attempt to restrict trading that subsidizes dirtier sectors. It could prohibit all trading between sectors or subcategories, thereby ensuring that, generally, costs go up in all sectors in the long run. This strategy eliminates the possibility of a sector or subcategory becoming a net seller and achieving a subsidy. In a more limited approach, the program could allow trading between firms in different sectors and subcategories only when the seller is in a cleaner sector than the buyer.

Finally, a program could just keep an eye on the net position of each sector—its actual emissions rate versus its standard—and make adjustments. Those sectors substantially beating their standards might have their standard tightened. Such dynamic adjustments may create a disincentive for the sector as a whole to beat its standards, but they are unlikely to have much effect on individual firms.

Direct and Indirect Emissions

The preceding discussion focused on the idea that product prices under a multisector tradable performance standard do not rise on the basis of their implicit carbon emissions. Clean production is encouraged, but choices among clean products generally are not. A related problem arises when sectors face choices between significant direct emissions and indirect emissions. A sector that is regulated under a tradable performance standard based on its own, direct carbon dioxide emissions from combusting natural gas or coal could instead consume electricity when the emissions are indirect. The sector faces a carbon price on coal and natural gas, but not electricity. Given that the electricity sector faces a tradable emissions standard, the electricity price will not reflect the embedded carbon emissions. This disconnect will, in turn, create inefficient incentives for firms to reduce direct emissions without sufficiently considering indirect emissions.

China's pilot programs dealt with this issue by both including a notion of indirect electricity emissions alongside direct emissions in both the compliance obligations and the established performance standard for regulated, non-electricity sectors (Munnings et al. 2016). Similar efforts are planned for the national emissions trading system as it expands to other sectors.

Price Management

Emissions trading programs frequently seek out mechanisms to reduce price variability (Fell et al. 2012). These programs include some of China's pilot programs as well as trading programs in California and the northeastern United States. There are several ways to implement such programs. Governments can buy and sell allowances, but this mechanism requires fiscal resources. Alternatively, programs can establish floor prices for allowance auctions as well as additional allowance reserves available at higher prices. These latter mechanisms have been used successfully in U.S. programs. China has focused on the former.

China's national emissions trading sector may face additional challenges if it also seeks to manage prices. Government intervention could be much more expensive as the program enlarges. Moreover, there is no auction mechanism that could be used to establish a floor price. All allowances are allocated on the basis of a benchmark. This consideration points to another useful area for further research.

CONCLUSION

China's national emissions trading system represents a significant step for China and the world, potentially doubling the worldwide volume of carbon dioxide facing emissions prices. The system's timing and stringency may be debated. But the fact remains that many more firms and individuals will see the cost of using fossil fuels more in line with true social costs. Moreover, the regulatory infrastructure is in place to increase the carbon price over time.

At the same time, relatively unique features in the China national emissions trading system raise new questions in policy design. The use of a multi-sector tradable performance standard is unprecedented at this scale. Can the potential for inadvertent subsidization of dirtier sectors and incentives to increase emissions be avoided or managed? Can indirect emissions be effectively handled through secondary regulation? Can price management tools be developed and implemented? These important questions deserve further research.

The government has created opportunities for adjustments. The testing phase, in particular, may be a time for the government to take stock of potential problems and make corrections. Meanwhile, the development and improvement phase offer the possibility of further reforms.

Stavins (1998) has referred to the sulfur dioxide trading program in the United States as "the grand policy experiment." Kruger and Pizer (2004) referred the EU ETS as "the new grand policy experiment." Given its size and scope, China's national emissions trading system could be viewed as "the third grand policy experiment." But unlike the previous two, this grand experiment is trying a different policy tool—a tradable performance standard—offering new challenges and new information for policy makers.

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The Nicholas Institute for Environmental Policy Solutions at Duke University is a nonpartisan institute founded in 2005 to help decision makers in government, the private sector, and the nonprofit community address critical environmental challenges. The Nicholas Institute responds to the demand for high-quality and timely data and acts as an "honest broker" in policy debates by convening and fostering open, ongoing dialogue between stakeholders on all sides of the issues and providing policy-relevant analysis based on academic research. The Nicholas Institute's leadership and staff leverage the broad expertise of Duke University as well as public and private partners worldwide. Since its inception, the Nicholas Institute has earned a distinguished reputation for its innovative approach to developing multilateral, nonpartisan, and economically viable solutions to pressing environmental challenges.

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