China's New National Carbon Market

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Abstract

On December 19, 2017, China announced the official start of its national emission 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 follow experience with China's pilot programs but contrast with much of the experience in the US and Europe. This makes the Chinese national carbon market both intriguing and challenging to those experienced with western emission trading programs. This paper walks through the design of China's new carbon market, contrasts it with more familiar, western programs, and highlights possible implications as well as research questions raised by this design.

Key Words: cap and trade, carbon price, performance standards, China

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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 the China carbon trading program in 2018, this number could double. Carbon pricing, through either tradable emission allowances or emission taxes, transparently equalizes the economic incentive to reduce emissions and is synonymous with conditions for least-cost regulation (Schmalensee and Stavins 2017).

At the same time, design choices matter. At the highest level, jurisdictions choose what to include and exclude from a trading program, as well as the overall stringency (as captured by the ultimate carbon price). Beyond this, there are important choices including allocation and revenue, certainty about emissions or prices, offsets, competitiveness mechanisms, and the use of overlapping policies. These and other choices have important consequences for the volume of emission reductions, the overall cost, and who bears that cost.

This paper explores key design choices in China's new national carbon market. In the next section, we provide some background for the context of China's policy. Why address climate change and why use carbon markets to do so? We then catalog some of the important features: particularly coverage and allocation. Finally, we dive into the allocation design, which essentially creates a multi-sector tradable performance standard. This 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) includes i) To achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early; ii) To lower carbon dioxide emissions per unit of GDP or the carbon intensity of the economy by 60-65% by 2030 from the 2005 level; and iii) To increase the share of non-fossil fuels (renewables and nuclear) in primary energy consumption to around 20% by 2030. Two domestic legally binding targets addressing China's climate pledges have been set for the 13th Five-Year-Plan (2016-2020) by the Chinese central government and also ratified by the Chinese Congress. 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 around 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 the 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 CO_2 emissions. This involves a long debate on whether China should introduce an emission trading system (ETS) or a carbon tax.

The recent decision to implement an ETS 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) favors more a certain emissions reduction than a certain carbon price which is under the control of the Ministry of Finance. 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 an ETS with a reasonably high price may be possible. A low carbon price may be less ineffective 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. A very large part of these companies are state owned and have significant expertise and experience in energy management. Finally, the ETS pilots in the 5 cities and 2 provinces over past three years have provided experience and momentum with the idea of an ETS.

Carbon Market Design

On December 18, the NDRC released the official document *Guidelines of national carbon emissions trading system (ETS) construction,* which was approved by the State Council. The document tells the guiding principles and steps of China's national ETS construction. According to the policy document released, China's national ETS construction 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 emission 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 extend to other sectors gradually.

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

The coverage and threshold

According to the information released by NDRC, China's national ETS will cover 8 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 & paper, and aviation. Companies with an annual energy consumption of more than 10,000 tons of coal equivalent, or roughly 26,000 tons of CO_2, in the 8 sectors must participant in the ETS.[1] As a result, China's ETS is going to regulate approximately 6000 enterprises, covering one half of China's total CO_2 emissions.

Like the 7 ETS pilots in 5 cities and 2 provinces, China's national ETS will only regulate CO_2 emissions and not other greenhouse gases. CO_2 emissions account for 83.2% of China's total GHG emissions.

Output-based allocation

Most emission allowances will be distributed freely by the government in the first phase of China's national ETS. Free allowance allocation has been widely used in first phase of most ETSs in the world. So far it is still not clear when and for what part of the allowances auction will be introduced. The primary free allocation method is the sectoral benchmark-based or sectoral performance standard-based. This is similar to output-based allocation proposed for trade-exposed industries proposed in 2009 legislation in the U.S. (Fischer and Fox 2011; US 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 based on production levels. In that sense, it is more analogous to multi-sector performance or intensity standards.

The output-based allocation approach largely comes from the experience of the ETS pilots. At the beginning, all the pilots 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 for setting appropriate benchmarks. But the

[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.

provincial/municipal Development and Reform Commissions (DRC) found that it was very hard for them to formulate a “reasonable and fair” grandfathering option.

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 the increased marginal costs to the users of heat and electricity. Second, there is still a relatively high growth in demand for electricity and heat in almost all regions of China, a situation different from that in most developed countries. These companies requested the DRCs give them additional allowances equal to that associated with increased uses of electricity and heat. Third, for the manufacturing sector, there are similarly many companies experiencing production capacity expansion that have better carbon emission performance due to the adoption of energy efficiency technology in the past. The grandfathering allocation approach would result an allowance shortage in those companies, punishing those with low emission but high growth. Finally, there are other situations where 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 in for these companies. Such ad hoc adjustments are not only costly for DRCs but also increase the opportunities for corruption in the process. As a result, all the ETS pilots changed from a mass-based approach to an output-based system as soon as the capacity and data for benchmark formulation were in place. This, in turn, will be the approach in the national ETS.

In practice, the allocation approach is described in documents used for the allowance allocation trials conducted by 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

$$a = bq \tag{1}$$

where b is the benchmarking CO_2 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 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 “subcatergorization” 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,

$$a_0 = \rho b q_0 \tag{2}$$

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

$$aa = qb - \rho q_0 b \tag{3}$$

Note that aa can be negative. In such 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 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 ETS is the handling of indirect emissions from electricity consumption. In particular, enterprises are not only responsible for mitigating on-site CO_2 emissions, or *direct emissions*, but also the CO_2 emissions associated with their consumption of electricity and heat, or *indirect emissions*. This 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 allocation mechanism also does not incentivize conservation of downstream carbon intensive products, like heat and electricity.

Over 50% of China's total coal is burned for electricity and heat production, and more than 70% of China's total electricity and heat is 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 NDRC, there are 11 performance standards for the power generation sector. The primary sub-categories are

- ultra-supercritical coal-fired power generation units with a capacity of 1000MW,
- 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, and
- other types of gas-fired power generation units.

The primary purpose for the sub-categorization 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 NDRC has to make for the power sector in order to secure a smooth launching of the national ETS. Sub-categorization, however, can lead to less cost-effective outcomes as it tends to focus incentives on efficiency improvements within technology sub-categories, rather than improving choices across sub-categories. We discuss this more below.

Provincial government role

Based on the NDRC document that was released previously, 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 the provincial government. As provincial governments face compliance with the domestic law on carbon intensity, for example, they may choose to use the national ETS as a tool to meet that objective. According to the earlier 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 part of the allowances.

A multi-sector tradable performance standard

One of the most interesting features of the China National ETS is that it is effectively a multi-sector tradable performance standard. Like 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 emission source equals a sector-specific benchmark emission rate multiplied by that source’s actual production level in that year. In aggregate, the emission limit varies with production. While the program begins in a single sector, electricity, it is slated to expand. Even within that sector, there are multiple subcategories or subsectors. Here, we briefly examine what this means and how it compares to more familiar cap-and-trade programs.

Single-sector tradable performance standards

There are a number of examples of *single-sector* tradable performance standards, most notably the U.S. lead phasedown (Hahn and Hester 1989; Kerr and Newell 2003) and 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 pollutions, these crediting standards for clean energy scale with production.

Compared to cap-and-trade programs, single-sector tradable performance standards have many similarities. Importantly, they establish a uniform emission price and encourage cost-effective mitigation within the sector. Those 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, while those facing more expensive mitigation do not—hence the cost-effectiveness condition is met. Moreover, production can also shift from dirtier to cleaner producers if that is a cost-effective way to mitigate for the sector as a whole.

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 2009). That is, while cap-and-trade policies put a positive price on all carbon dioxide emissions, tradable performance standards only put a price on carbon dioxide emissions *above the standard.* This 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 based on production levels (though they operate inside of an overall cap-and-trade). They are frequently proposed as a way to mitigate emission leakage and competitive impacts (US EPA 2009).

The downside to this approach is that it discourages cost-effective mitigation *across sectors*. Cap-and-trade programs raise the price of products so they reflect the emissions associated with the product. For example, electricity prices rise to reflect the carbon dioxide emissions of electricity. This leads users to conserve electricity based on 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, based on fuel or production technique, cleaner production is no longer incentivized to the same degree. In fact, if those subcategories with a higher emission rate can mitigate cheaply, subcategorization can even *raise* the emission rate of the sector as a whole. That is, the emission rate of the sector as a whole is the average of the subcategories. If production shifts to higher-emitting subcategories, the emission rate can go up even as the emission rate in each subcategory declines.

The Clean Power Plan (CPP) rule in the U.S. attempted to deal with this problem by creating special "gas-shift emission reduction credits." In the CPP, natural gas combined cycle (NGCC) plants faced one standard and steam plants another, higher emission rate standard. In order to encourage production to shift to NGCC plants, rather than stay the same or even shift away from NGCC, 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, this can also lead to higher emissions if the sectors with easy-to-achieve standards have higher emissions per dollar (or yuan) of value added. That is, the emission 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 is an interesting topic for further research, but here we speculate on a few possibilities. One solution would be to set more challenging (albeit higher emission level) standards for dirtier sub-categories and dirtier sectors (per dollar of value added) so they are unambiguously net buyers. Alternatively, as in the CPP, the program could assign additional credits to cleaner sectors. Both approaches effectively take a standard that differentiates among sectors and move closer to a single standard. Under a single standard (e.g., emissions per dollar of value added), it clear that the aggregate emission rate (per dollar of GDP) is declining.

Rather than moving towards harmonization, one could try to restrict trading that subsidizes dirtier sectors. One could prohibit all trading between sectors or sub-categories. This would ensure that, generally, costs go up in all sectors in the long run. This 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 sub-categories only when the seller is in a cleaner sector.

Finally, a program could just keep an eye on the net position of each sector—its actual emission rate versus its standard—and make adjustments. Those substantially beating their standards might have their standard tightened more. Such dynamic adjustments may create a disincentive for the sector as a whole to beat their standards, it is unlike 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 based on 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 and indirect emissions. That is, imagine a sector that is regulated under a tradable performance standard based on its own, direct carbon dioxide emissions from combusting natural gas or coal, but could instead consume electricity where the emissions are indirect. The sector faces a carbon price on coal and natural gas, but not electricity. Given the electricity sector faces a tradable emission standard, we know that the electricity price will not reflect the embedded carbon emissions. This will, in turn, create inefficient incentives for firms to reduce direct emissions without sufficiently considering indirect emissions.

China's pilot ETSs 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 ETS as it expands to other sectors.

Price management

Emission trading programs frequently seek out mechanisms to reduce price variability (Fell et al. 2012). This includes some of China's pilot programs as well as trading programs in California and the Northeastern U.S. There are a number of ways to implement such programs. Governments can buy and sell allowances, but this 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 the U.S. programs, while China has focused on the former.

The China National ETS may face additional challenges if it also seeks to manage prices. Government intervention could be much more expensive as the program is much larger. Moreover, there is no auction mechanism that could be used to establish a floor price. All allowances are allocated based on a benchmark. This points to another useful area for further research.

Conclusion

China's national ETS represents a significant step for China and the world, potentially doubling the worldwide volume of carbon dioxide facing emission prices. The 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 ETS raise new questions in policy design. The use of a multi-sector tradable performance standards is unprecedented at this scale. Can the potential for inadvertent subsidization and/or 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 are important questions that 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 has referred to the SO_2 trading program in the United States as "the grand policy experiment" (Stavins 1998). Kruger and Pizer referred the EU ETS as "the new grand policy experiment" (Kruger and Pizer 2004). Given its size and scope, it seems appropriate to view the China national ETS as "the third grand policy experiment." But unlike the previous two, this grand experiment is trying a different policy tool—a tradable performance standard—with new challenges and new information for future policymakers.

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