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Exploration on Covered Sector System of China's ETS in Theory and Practice

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Abstract: The Emission trading Scheme is an important economic measures to abate greenhouse emission, and its prime step is to determinate the covered sector as well as threshold of covered emission sources within specified sector. In theory, the more sectors covered within ETS, the better environmental effectiveness and efficiency of economic operations can be achieved. In practice, however, all sectors cannot be properly embraced in ETS, and there will be other more appropriate reduction options for some sectors according to economic feasibility analysis on consideration of technological factor, and motivator difference of emission reduction. Some conclusions are useful for construction of China National ETS in near future by analysis of covered sector system in theory and practice.

Keywords: emission trading scheme, covered sector, point of regulation, threshold

INTRODUCTION

United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol were the basic international laws to address the global climatic change and regulate the GHG emissions. The introduction of Kyoto flexible mechanism realizes the combination of market instruments with international reduction action. In the background of global joint efforts, the emission trading scheme (ETS) has ever become the main option for regional, national and local emission reduction. By the year of 2014, Europe Union, Switzerland, New Zealand, California, Quebec and Tokyo Metropolitan have already established mandatory emission trading market. As the world's biggest emission nation, the China government definitely set out trajectory for progressive establishment of domestic carbon market in National "Twelve-Five" Plan, which is applied for achievement of China's 2020 GHG intensity reduction target. Meanwhile, seven provinces and cities, including Beijing, Shanghai, Tianjin, Chongqing, Guangdong, Shenzhen and Hubei, have been identified by NDRC as the first ETS pilots. During the period from June 18th 2013 to June 19th 2014, all the local carbon pilots were fully operational. The China's National ETS has been under consideration, and scheduled to be implemented before 2020.

As a market-based instrument, the superiority of ETS is to consolidate the environmental effect with economic efficiency in the form of cap-and-trade program. On one hand, owing to the scarcity of emission allowance within the cap, the cost of covered entity will increase through internalization of environmental externality resulted from their GHG emissions, in order to transfer price signals and motivate the investment in emission reduction activities. The economy-wide cost could be lowered furthest by allowing participants of different emission reduction potentials to trade emission allowances allocated by government. On the other hand, the cap setting could decide volume of GHG gross emissions within a definite jurisdiction and time-framework thereby ensure that the existing environmental targets be achieved in a dynamic balance [1].

The design of covered sector system, which is used for determination of appropriate participant, is the key step in the whole construction of emission trading system, with the main elements including coverage of sector, scope of GHG, selection of regulation point, threshold setting, as well as flexibility provisions under exceptional conditions. The primary objectives of this text are as follows:

- Summarize the existing theories related to covered sector system of ETS;
- Carry out the comparative analysis of various covered sector system practice;
- Put forward policy advice towards the covered sector system in the construction of China's National ETS.

Basic Theories of Covered Sector System

Concepts of GHG Emission related Sources

The sectors to be covered in the ETS are closely related to the national and local GHG emission related activities, embracing fossil fuel combustion, industrial process, agriculture, LULUCF, and waste disposal. According to statics, fossil fuel combustion activities cover the biggest amount of GHG emission, and sectors involved include energy production and transition, industrial production and manufacturing, transportation, and other energy end-use related household and

commercial sectors. Industrial process is the other main sources of GHG emissions, the emissions of which is defined as the chemical or physical reaction emissions other than energy activities.

Any GHG emission source could be divided into two levels of emission entity and installation, the former consists of industrial and commercial (group) corporations, public and other establishments, while the latter covers independent production and manufacturing facilities, buildings and other construction structures. Under the general situations , each emission entity could involve at least one installation or more. In addition, the emission activities could also fall into direct and indirect emissions, the former refers to actual emission produced from the emission entities or installations, while the latter includes the entities, which purchase the electric or heating power, or sell fossil fuel and other GHG related products, and the process only cause emission increase of related direct emission sources instead of themselves [2].

Criteria for covering sectors

The upper limit of ETS implemented is determined by the total volume of all the GHG emission sectors, but not all the sectors are covered at a time. Policymaker should adopt a series of acceptance and rejection criteria by balancing the environmental effect and economic efficiency, including breath of coverage, sectorial emission reduction considerations, emission measurability, and administration cost.

Breath of coverage

The coverage of ETS could directly impact the environmental effect of ETS. In general, the more extensive ETS covered, especially putting these large emission sources with prominent emission volumes under control, the much easier for policymaker to realize the emission reduction target through implementation of ETS. Expanding the covered sector will leave less emission sources outside the ETS, and assure of certainty of environmental objective pursuit by the program. If the scope is large enough, even if instability of uncovered sectional emission cannot be accurately controlled, national or local entire emission reduction targets will not be substantially influenced by unpredicted changes, owing to the small proportion of uncovered sector in total emission budget [3]. Furthermore, enlarge the coverage of sector would also extend the influence of price signals, and motivate more industries to search for more cost-effective emission reduction tactics in a more extensive fields, and the leakage risk from covered sector to uncapped field will be further lowered.

Sectorial emission reduction considerations

The sectorial self-emission reduction factor need to be divided into competitiveness of sector cost of emission reduction, and potential of emission reduction. First of all, any sector's operating cost will increase if covered in a specified ETS, consequently, some sectors with high cost pass-through capability and facing less competitiveness in international markets are preferred to be absorbed in ETS. That's why power sector was always the first selection. If the sectors which must be confronted with intensive competitiveness in international markets are covered in ETS, their competitiveness of exports will be inevitably impaired, thus policymaker also need take all other necessary steps, such as free allocation of emission allowance, or other subsidy measures. Secondly, there existing different reduction cost among each sectors, hence the sector with lower reduction cost should be selected in priority. In the background of covered sector's expansion, more sectors or emission resources with different reduction costs can be absorbed at the same time, so as to lower potential entire cost by allowance trading. Thirdly, policymaker should take first consideration of those sectors with high reduction potentials, in respect that remarkable reduction effects can be obtained by easier investment in the fields of emission reduction technology [4].

GHG emission measurability

The measurability of GHG emission is an important technical factor of covered sector systems. Accurate measurement of emissions is needed to ensure that the allowances surrendered at the end of a compliance period by the covered entities correspond to their actual emissions, and that any allowances that have been traded are in fact surplus to those emissions [5]. Some sources are better suited in accurate monitoring, or calculation by using a proxy method with reliably inferred from verified data, such as output of products or input of fossil fuel. However, the accurate measurement of emissions may prove to be very difficult, owing to the fact that it may be not feasible or prohibitively expensive to monitor emissions directly, and there may be no reliable protocols for using proxy data to estimate emissions. Therefore, the regular operation of ETS will be strongly impacted if covering such emission resources.

Administration cost of emission trading system

Policymaker should also take consideration of administration cost in the implementation of ETS. If allowing small or diffuse emission sources covered into ETS, the data collection of emission level, monitoring and allowance trading are sure to result in prohibitive administration cost. For instance, although GHG emission monitoring of individual vehicles is feasible, maximal difficulty in administrations may be incurred when including every diffuse emission sources. Oneproxy way is to regulate the product or fuel industries in upstream, or linking these diffuse emission

sources with some offsets mechanisms. If the measurement of these small sources is difficult or impossible both in downstream or upstream, the policymaker can only return to command-control based measures such as implementing emission standards, energy efficiency standard or other efficient means [6].

Options for Point of Regulation

After the determination of covered sectors, policymaker need to decide which part of industry chain is more appropriate in ETS, in order that bigger proportional GHG emission could be effectively covered. These regulated entities could be direct emission sources as well as the indirect one. Thus, upstream and downstream coverage are divided as per different point of regulation in the industry chain. Upstream coverage means that the point of regulation is closer to where carbon substance firstly enters into the economy, and the production or supply entities of fossil fuel and other GHG emission materials are covered in ETS. Downstream coverage refers to locations where GHG are emitted, and the enterprise or other entities, which emit GHGs directly to atmosphere, should be covered in ETS.

The first consideration on regulation point is the feasibility of emission measurement. If the regulated entity is located at the upstream of industry chain, the direct emission data are unavailable for monitoring, the proxy method for measurement must be adopted. For instance, if the fossil fuel suppliers are covered in ETS, the proxy method to calculate GHG emissions based on carbon content of fossil fuel is required. To the opposite, if the regulated entity situated in downstream, the real-time monitoring of emissions and proxy method are both feasible. So the proxy method is the only way for upstream coverage, as well as the important options for downstream. But it should be noted that the data obtained through proxy method may be greater than the actual volume of GHG emissions, especially when fossil fuels that are used by some industries wholly or partially as raw materials are absorbed into products rather than emitted. Under such situations, upstream coverage would be a little more complicated, requiring exemptions or crediting for non-emission uses.

The incentive of emission reduction is the second important consideration for selection of point regulation. In general, as for individual enterprise, the emission reduction costs may pass through to downstream customers in the form of higher prices, or to upstream suppliers in the form of reduced demand for fuels and other production inputs, or absorbed by the firm itself by lowering profits. The critical problem is whether cost change can create direct or indirect incentives for emission reductions. It is generally agreed that there will be more incentives in downstream rather than upstream. Because the downstream enterprise, as the direct GHG emission sources, may be pressed by cost increase, and have more incentive to improve production process or adopt substitutable raw material to decrease emission. While the upstream covered enterprise, because of indirect emission, have no choice but to internalize the compliance cost in its product prices, and stimulate downstream enterprise to reduce emission through price signals [7]. But the cost pass-through effect may be weakened because of rigid demand of upstream products.

Administration cost is the third important consideration for selection of regulation point. Compared with upstream, the downstream coverage brings about higher administration cost. Because the quantity of enterprises at downstream of industry chain is evidently more than the ones at upstream, and more administration resources need to be required. Furthermore, there may be carbon leakage in downstream coverage, and require policymaker to adopt other command-control instrument for effective regulation.

By analyzing different influential factors, we can make the conclusions that: upstream mode can control the supply of dominant substance which produces GHG emissions, with the advantage that administration cost will be lowered owing to less regulated enterprises, as well as with the shortcoming including inaccurate emission data by using proxy method and indistinct incentive of emission reduction. If downstream mode is adopted, more emission sources need to be covered with definite scale economics effect, precise emission monitoring and direct incentive for reducing emissions can also be obtained [8]. One question has been raised that whether downstream and upstream coverage can be combined together. Under such hybrid mode, big emission sources are covered in downstream while the small and diffuse ones in upstream, by avoiding double counting and carbon leakage. In the design of covered sector system, the adaptation of hybrid coverage would expand the coverage as large as possible, and achieve the objective of optimal emission reduction effects, by overcoming the faults appears in single upstream or downstream mode and bearing the least administration cost.

Threshold for Covered Entities

Setting threshold is another important issue in the design of covered sector system. The form of threshold could be based on volume of GHG emissions or other performance indicator, such as output of standardized products or input of fossil fuel equivalent. For example, output is always used in power sector while the GHG emission volumes are often adopted for industry sector

which includes various complicated products. The threshold value would directly influence the administration cost of government and participation cost of regulated enterprises. On one hand, if some small scale firms with less emission volumes are to be covered, the balance should be further considered between environmental effectiveness and administration cost, and small emission units will be excluded by setting specified threshold value. Through such screening method, a small quantity of big emission entities or installations will be chosen within ETS coverage, while lots of small units are left for other emission reduction measures. On the other hand, the financial burden of covered emission entities should be also considered. In general, the big enterprises with a large amount of emissions are much easier to dilute participation cost rather than small ones [9]. In consequence, the small emission sources within the scope of covered sectors, which are more sensitive to costs, need to be removed from ETS by setting a higher threshold value.

In addition, a quasi-threshold, or called preparative threshold, should be also introduced. By setting such threshold, the emission sources within covered sectors, the emission volume of which is lower than quasi-threshold value but higher than threshold value, must bear the mandatory obligation of reporting emissions, but excluded from surrendering emission allowances. By setting quasi-threshold, policymaker intends to embrace these reporting entities or installations in near future, but temporarily make them collect emission data and prepare for compliance in advance.

Comparisons on covered sector systems of typical existing ETS

According to the study report “carbon pricing status and trends” newly issued by World Bank, there are fifteen nations or sub-national cap-and-trade systems in the world, and covered sector systems in each ETS have their own respective features. Based on the types of covered sectors, the system can be classified into coverage of single sector and multiple sectors. RGGI (Regional Greenhouse Gas Initiative) is the typical representative of the former type, while all the other fourteen ETS covered the multiple sectors. Furthermore, owing to different regulation point, the multiple sectors system can be classified into three types, including downstream, upstream and hybrid modes. Among existing ETS practices, the majority of covered sector systems, following the path of EU-ETS, adopt the single downstream coverage. Only NZ-ETS choose the single upstream mode, while California and Quebec are ready for hybrid mode after 2015.

EU-ETS: The expanding downstream coverage along with flexibility provisions

In 2005, Europe Union took lead to start the global largest regional carbon market, the EU-ETS. As for the covered sector system, there are three characteristics appeared:

Firstly, a progressive coverage mode was adopted in emission trading design. During phase I (2005-2007), only energy and part of industry sector were covered, only involved with CO_2, easier to be measured at the early stage. During the last year of Phase II (2008-2012), the covered sector was expanding to civil aviation in transportation sector. After entering into Phase III (2013-2020), more industry sub-sectors, requiring more sophisticated emission monitoring technology, and more sensitive to international competition, were included within the coverage of ETS. Meanwhile, other types GHGs were also added.

Secondly, the covered sector system of EU-ETS adopted fully downstream mode. After setting appropriate threshold value, a large quantity of small emission sources were excluded from EU-ETS, but the emission level of covered installations still occupied 45% of total emission volume [10].

Thirdly, flexibility provisions were introduced in the design of covered sector system, involved with "opt-in" and "opt-out" clauses, so as to address the industry distribution difference among EU members. The "opt-in" clause refers to the conditions that allowing EU members' unilateral covering of the emission sources within covered sector but under the threshold value, as well as uncovered sectors and GHGs outside the scope. Expanding coverage of additional emission sources, sectors or GHGs would improve the effectiveness of ETS, but any unilateral covering decision made by member states must be authorized by EU commission in advance. The "opt-out" clause is opposite from the former one. It allows covered emission sources, which shall be in conform it to certain standards, to be excluded from ETS unilateral permitted by member states. But the member states are required to carry out other equivalent emission reduction measures to regulate exited sources. During Phase III, EU commission permitted member states to release some installations with emission volumes slightly more than the threshold value. As a result, 4200 covered installations were relieved from EU-ETS, the emissions of which taking up only 0.7% of total volume. The exclusion of these installations would not influence the integrity of EU environmental objective, but prominently lowered the administration cost for each member state.

NZ-ETS: Covered in progressive upstream mode

The New Zealand emission trading scheme was activated in 2008, and there are also three features in its covered sector system. Firstly, progressive coverage was adopted in NZ-ETS, including forestry, stationary energy, liquid fossil fuel supply, industry and manufacturing, fishery, waste disposal, and synthesized GHGs production covered one by one during the period from 2008 to 2013. Secondly, the regulation point of NZ-ETS was upstream mode, almost covering all kinds of emission related sectors and all six Kyoto GHGs. After screening out the little emission source by setting threshold, the coverage take up 55% of gross emission volume. Thirdly, some special sectors were chosen in NZ-ETS, which were not covered by any other ETS, such as forestry, fishery and waste disposal sector.

RGGI：A single downstream coverage mode

RGGI was the first US trans-states GHG emission cap-and-trade program, which was put into operation in 2009. The feature of covered sector system in RGGI is single covered sector and full downstream mode. The CO_2 emission covered in RGGI all come from thermal power generation sector, and threshold value for particular installation is the 250,000MW installed generating capacity. The single power sector coverage had multiple advantages, such as facilitating emission measurement, reducing administration cost, and improving the political acceptance of ETS. However, the breath of coverage only occupied 22% level of nine RGGI states' gross volume, which limited the contribution of ETS for achieving national emission reduction targets.

California Cap-and-Trade Scheme: Ahybrid covered system

California cap-and-trade program was formally established in 2013. The progressive sectorial coverage as well as the hybrid coverage are the two prominent features of the covered sector system. During the first compliance period (2013-2015), only downstream mode was adopted covering the whole power sector and parts of industry sector, and the threshold for individual emission sources was 25,000 $MtCO_2e$. But according to designing plan, during the second compliance period (2016-2018), the coverage of California's ETS would extend to upstream industry sector, including suppliers of transportation fuel, natural gas and liquefied gas, so as to cover the emission of small and diffuse downstream sources in a proxy way, involved with household, commercial and transportation sectors. The GHG coverage would take up nearly 85% of total emission volume of California, and thus the emission trading program played an important part in achieving the emission control target.

China's Carbon Pilots：Learning by doing

In the design of covered sector system for China's seven newly established carbon pilots, economic development and industry distribution of different provinces and cities were further considered to confirm respective sector coverage and threshold, as well as commonly use of downstream mode including direct and indirect emissions. On one hand, all the pilots covered direct emissions from energy and parts of industry sector, while the five of seven except Hubei and Chongqing incorporated indirect emissions from public and commercial buildings, and only Shanghai selected parts of transportation sector into ETS. On the other hand, there are also various features among value, nature and hierarchy setting of threshold when comparing with seven pilots. First of all, in the aspect of threshold value against different sectors, Beijing, Tianjin, Hubei and Chongqing adopted uniform threshold level for various covered sectors, while Shanghai, Guangdong and Shenzhen used differentiated level for every capped sector; Furthermore, as for nature of threshold involved, only Hubei selected the energy consuming equivalent standard similar to TMGETS, while the other six pilots mainly used CO_2 emission equivalent as threshold; Finally, with respect to threshold hierarchy, Beijing, Shanghai, Shenzhen and Hubei equally set the quasi-thresholds for emission reporting and verifying (only Shenzhen).

Recommendations on covered sector systems of incoming China's National ETS

The establishment of covered sector system ought to lay stress on expanding sectorial coverage step by step.

During the early stage, when designing the covered sector system of national ETS, the policymaker should pay more attentions on data collection of emission sources, as well as institutional perfection and modification, rather than expanding the sectorial coverage.

Firstly, multiple parallel sets of single sector system and single system of mixed sectors are two options. If take practice of mixed sector mode existing in EU-ETS for reference, those sectors with un-intensive environment of competition, low emission reduction cost, and good reduction potentials, could be covered into a single emission trading system in the first place, including large power emission sources and parts of industry sub-sectors. When switching to mixed sectors option, policymaker ought to realize the utmost compatibility of diverse sectorial features, and avoid difficulty of implementation level when absorbing multi-class sectors into national ETS during early stage.Another option is the RGGI mode by using a single sector system to facilitate the operation of ETS and improve the economic efficiency, under which all

the ingredients involved with cap setting, allowance allocation, flexible performance, MRV and so on, act according to actual circumstances. However, if putting several single sector system into action at the same time, more administration resources will be required. Consequently, mixed sectors option would be more feasible for China's future national ETS.

Secondly, when referring to regulation point, the upstream and downstream modes are both optional. The upstream mode can reduce the quantity of capped emission sources, and lower the administration costs, but the critical issue is that emission measurability should be based on concise proxy method to avoid omission and double counting which requiring long-period accumulation of experience and scientific evaluation. To the contrary, the downstream mode was best fit for implementation of early stage national ETS, and the data collection rest on real-time emission monitoring, or simpler proxy calculation method. Meanwhile, less sectors or emission sources will be covered during the early stage, which could not aggravate the administration burden. Thus, policymaker should take adoption of downstream mode for China's early national ETS.

Thirdly, screening out the little emission sources is main purpose of threshold setting. By setting appropriate threshold value, the large emission sources will be held and the little ones are all excluded in order to lower the administration cost. By reviewing the existing practice of EU-ETS and China's domestic carbon pilots, the nature of threshold could be set in accordance with features of specific covered sector, but the refinement should not be excessively complicated. Threshold hierarchy is also advisable that quasi-thresholds can be introduced for future capped emission entities and installations, which will be formally absorbed into ETS after perfecting data collection and compliance preparation.

The perfection of covered sector system should aim at maximum breath of coverage.

After the successful implementation and a certain period of experience accumulation in nation ETS, the perfection of covered sector system should incline to expanding breath of coverage.

To start with, there may be two directions for expanding covered sectors. If single mixed sector system was adopted at the early stage, some downstream sectors, sensitive to participation cost, could be gradually covered in ETS, and some industries, which are confronted with severe carbon leakage, could be allocated with free allowances or dealt with by other compensation measures. In addition, along with perfection of emission monitoring technology and proxy method, some GHGs and related sub-sectors, which were not suitable within coverage in the past, can be capped under national ETS. If multiple parallel single sector systems were put into operation during the early stage, the two optional ways for expanding new sectors is to establish independent systems, and link them into a unified national ETS. Owing to compatibility of diversified systems, it is apparently more difficult than mixed sectors single system mode.

Subsequently, the experience to be got from the second compliance period of California cap-and-trade program can be used for reference, and the hybrid mode could be adopted in future China National ETS. The fossil fuel suppliers in upstream could be absorbed into ETS by using price signals pass-through effect to influence small or diffuse emission sources in downstream which are disqualified for coverage within ETS. However, it should be noted that the domestic price of fossil fuel should be rated by market principle, and then upstream mode may take effect in pass-through of price signals.

Finally, specific threshold value can be lowered to include more emission sources. Some emission entities or installations, which bear reporting obligations at the early stage, could be covered into ETS by adjusting threshold value downwards. At the same time, the originalquasi-thresholds also need to be lowered so as to prepare for further expansion of coverage.

The flexibility provisions also need to be introduced.

Just as the diversity embodied in the sector coverage and threshold stipulation of China's seven carbon pilots, policymaker of central government should take full consideration of disproportion of industry distribution and difference in economic development level when designing covered sector system of future national ETS. The "Opt-in" and "Opt-out" provisions implemented in EU-ETS could be used for reference. Under the unified emission trading system of Top-down mode, the central government could authorize local government to cover or exclude some specific sectors, GHGs, or emission sources, to a certain degree apart from the covered sector system of national ETS. However, these rules can only be activated when in conformity with definite prior conditions. The central government has the authorities to make inspection of "opt-in" sectors or entities suggested by local government, to ensure that enlarging the coverage would not increase administration cost proportionately. As for the "opt-out" sectors or entities agreed by local government, central government should set a more strict censorship standard, to ensure that the exclusion of specific sector or entities would not bring

about major impact to coverage of ETS and integrity of environmental effect. The local government must provide other feasible measures to regulate the excluded sector or emission sources.

CONCLUSION

After the implementation of China's seven local pilots, the China's national ETS have already been under scheduled in near future. When designing the covered sector system, the policymaker should balance the relationship between environmental protection and economic development, and take full consideration of the four covering criteria including breath of coverage, features of sectorial emission reduction, administration cost and measurability of emission. Meanwhile, the feature of multi- stages embodied in China national ETS should also be focused on combined with the practices of foreign and domestic seven carbon pilots.

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