



International carbon markets under the Paris Agreement: Basic form and development prospects

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Abstract

Article 6 of the Paris Agreement introduces two international carbon markets that receive extensive attention and are expected to play an important role in the post-2020 climate regime. Three key elements of the two international carbon markets, including the scope, the types of tradable units and the governance, are identified, as the basis to clarify their basic forms. Based on the key issues and their different designs identified in negotiations, this study analyzes the contributions and challenges for China to participate in international carbon markets. Considering the inherent needs of climate change mitigation, climate finance, the development of a green “Belt and Road” and the China South–South cooperation in climate change, along with the existing domestic capacities on market mechanisms, this study puts forward the short-, medium- and long-term development prospects of the two international carbon markets.

Keywords: Paris Agreement; International carbon markets; Cooperative approaches; Sustainable development mechanism; Climate change

1. Introduction

Article 6 of the Paris Agreement established two international carbon markets through the cooperative approaches (CAs) under Articles 6.2–6.3 and the sustainable development mechanism (SDM) under Articles 6.4–6.7 (UNFCCC, 2015). These could be used by Parties to achieve their nationally determined contributions (NDCs) and increase the ambition of the mitigation targets in the future. On the one hand, roughly half of the Parties intend to use the international carbon market in post-2020 (Chen et al., 2018). On the other hand, the Carbon Offset and Reduction Scheme for International Aviation aims to provide a large amount of demand for the international carbon market units (Cames et al., 2016). Therefore, the

international carbon market is expected to play a crucial role in post-2020 climate regime (Koakutsu et al., 2016).

Currently, the Subsidiary Body for Scientific and Technological Advice (SBSTA) summarizes the views submitted by Parties in order to support the development of the guidance for CAs and the rules, modalities and procedures for the SDM (UNFCCC, 2018a, 2018b). Therefore, it is important for China to accurately grasp the development of international carbon markets by identifying the key issues in negotiations and their basic forms. Moreover, analyzing the contributions and challenges for China to participate in the international carbon markets and their development prospects can help maximize their roles in China. Therefore, in this work, we identify the key elements of the international carbon markets to clarify their basic forms based on the literature review. The key issues in negotiations and their design options are identified through informal documents of the SBSTA meetings. On this basis, we analyze the contributions and challenges for China to take part in the international carbon markets. This study puts forward

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the development prospects of the two international carbon markets in accordance with the inherent needs of climate change mitigation, climate finance, the development of a green “Belt and Road” and the South–South cooperation on climate change, along with the existing domestic capacities on the market mechanisms.

2. International carbon markets under the Paris Agreement

Discussions related to the international carbon markets under the Paris Agreement could be traced back to the 16th Conference of the Parties (COP16) to the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun in 2010, which decided to consider the establishment of one or more market mechanisms to enhance the cost-effectiveness of mitigation actions and elaborated the principles of market mechanisms as shown in Table 1. The COP17 in Durban formally established two international carbon markets, namely, the framework of various approaches and the new market mechanism. Since Durban, there has been hardly any progress on these two market mechanisms. However, the COP21 in Paris reintegrated international carbon markets into the agreement, removed the framework of various approaches and the new market mechanism and replaced them with the CAs and the SDM. As shown in Table 1, the two international carbon markets under the COP21 looks quite similar to those under the COP17. It seems that the CAs and the SDM inherit the key components of the framework of various approaches and the new market mechanism. Therefore, the discussions on the basic forms of CAs and the SDM could be built on the

previous discussions under the COP17 in Durban (Koakutsu et al., 2016).

In spite of the slow progress of the framework of various approaches and the new market mechanism in the negotiations, the discussions on these issues have continued within the academic circles (Baron et al., 2009; Schneider and Cames, 2009; Sterk et al., 2015). Moreover, some countries have started pilot programs to facilitate their development (WB, 2015; Kfw, 2013). Therefore, based on the previous research (Gao et al., 2016), we identify the key elements of the international carbon markets as the bases by which to clarify their basic forms (Fig. 1).

2.1. Cooperative approaches

Cooperative approaches enable Parties to use ITMOs toward their NDCs, increase the ambition of mitigation actions, promote sustainable development, and ensure environmental integrity. The Parties are requested to apply robust accounting to avoid double accounting under CAs. In this sense, CAs could be regarded as a framework that develops guidance for robust accounting to govern the transfer of ITMOs from various types of market-based activities (ADB, 2018).

- (1) The scope of CAs refers to the types of mitigation activities that are governed by the guidance for robust accounting developed under CAs. Article 6 does not seem to place a limit on the scope of CAs, in that, technically speaking, any mitigation activity could generate ITMOs. Currently, CAs commonly involve the linking of the emission trading systems (ETS) of different Parties, direct government-to-government transfers and the use of international crediting mechanisms that might include bilateral crediting mechanisms governed by Parties (e.g., Joint crediting mechanism) and the SDM proposed under Article 6.4 (Schneider et al., 2017; Rocamora et al., 2017; Cames et al., 2016). However, due to the different types of governance between CAs and the SDM, whether the tradable units generated by the SDM could be regarded as ITMOs remains a controversial issue in the negotiations.
- (2) The specific type of ITMOs under CAs depends on which type of mitigation activities generates them. If an ITMO comes from the linking of different ETS, it could be the tradable unit from a national carbon market, such as European Emission Allowance from EU-ETS. If it comes from direct government-to-government transfers, it could be similar to the type of the NDC, such as the renewable energy certificate from India. An ITMO could also be the emission reduction credit if it is generated by the bilateral or multilateral crediting mechanism, such as the JCM credits from Japan.
- (3) Article 6 does not specify the governance of CAs. Most Parties consider CAs as a decentralized mechanism because CAs could be regarded as the successor of the framework of various approaches. However, controversies remain when it comes to negotiations on the

Table 1
UNFCCC discussions related to the international carbon markets under the Paris Agreement.

Climate Change Conference	UNFCCC discussions related to international carbon markets
COP16 in Cancun (2010)	Principles of carbon markets: voluntary participation, broad segments of the economy, environmental integrity, net decrease, and meeting part of the mitigation targets
COP17 in Durban (2011)	The framework of various approaches: a framework to govern internationally traded units from different mechanisms designed by all Parties (Koakutsu and Usui, 2014); standards that deliver real, permanent, additional and verified mitigation outcomes; avoid double counting; and achieve net decrease New market mechanism: scale up mitigation activities to broad segments of the economy and achieve net decrease
COP21 in Paris (2015)	CAs: a framework to govern various types of market-based activities (Rocamora et al., 2017), allow Parties to use internationally transferred mitigation outcomes (ITMOs) to achieve NDCs, ensure environmental integrity, and promote sustainable development SDM: a new market mechanism to promote mitigation, support sustainable development, and deliver an overall mitigation in global emissions

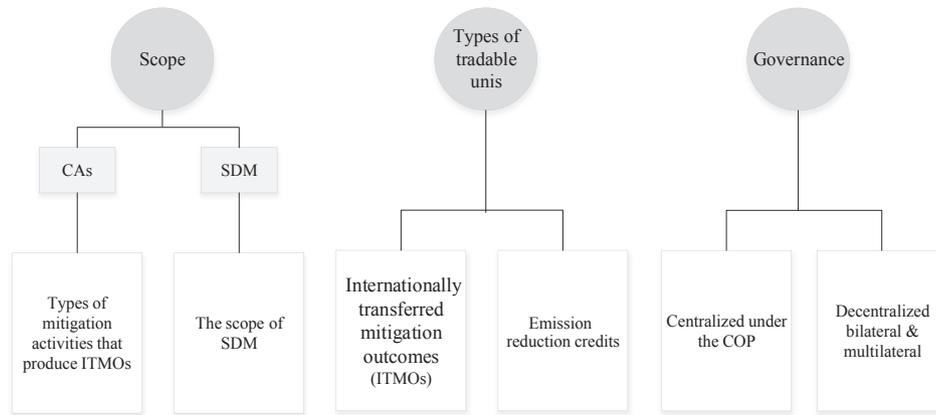


Fig. 1. Key elements of the international carbon markets.

issues related to the extent of decentralized governance and the role of the Conference of Parties serving as the meeting of the Parties to the Paris Agreement (CMA).

2.2. Sustainable development mechanism

The sustainable development mechanism, which is established under the authority and guidance of the CMA, allows Parties to use emission reduction outcomes generated by this mechanism as a host country or a buyer country to achieve their NDCs. It aims to promote mitigation and foster sustainable development while ensuring overall mitigation in global emissions (Healy, 2017).

- (1) The SDM could be regarded as the successor of the clean development mechanism (CDM) in post-2020 to some extent. Although the CDM involves the program of mitigation activities, it remains a project-based market mechanism with limited emission reductions. Most Parties believe that the SDM would cover mitigation activities at the sectoral, sub-sectoral or cross-sectoral levels (Cames et al., 2016). Furthermore, there is a wealth of experience and expertise with the project-based mechanisms, and discussions on the transition of the CDM to the SDM are also under way (Marcu, 2014). Therefore, both the project- and sectoral-level mitigation activities would be incorporated in the SDM.
- (2) Although Article 6 does not mention the mechanism type of the SDM, the additionality presented in Article 6.4 implies that it would be a crediting mechanism (Marcu, 2016; Zeng and Dang, 2017). Therefore, the type of tradable unit under the SDM is the certificated emission reduction credit.
- (3) The SDM will be a centralized mechanism which is supervised by the CMA. However, considering the bottom-up architecture of the PA, the host country government would be more involved compared with the CDM (Marcu, 2017b).

3. Key issues on international carbon markets in negotiations

3.1. Key issues on CAs

3.1.1. Scope of the guidance and governance

As shown in Fig. 2, the scope of the guidance for CAs is closely related to its governance. Two views can be identified in relation to the scope of such guidance (ADB, 2018), the guidance only covers accounting rules, and therefore, can only ensure that the transfer of ITMOs is represented in an accurate way to avoid double accounting; and, the guidance needs to ensure environmental integrity and promote sustainable development, which means it covers how you transfer an ITMO, as well as what you transfer. In this view, an ITMO should meet certain environmental characteristics. When the scope of the guidance only covers accounting rules, Parties will make their own criteria for ensuring environmental integrity of an ITMO, which will be transparent to other Parties based on the transparency provisions under Article 13, and the bilateral and multilateral aspect of CAs will ensure a check for environmental integrity. This option is a completely decentralized and unbinding climate change regime. When the scope of the guidance extends to ensuring environmental integrity and promoting sustainable development, there are two kinds of governance available: (i) a decentralized governance, and (ii) a centralized governance. In a decentralized governance, the CMA only sets general principles or guidelines for environmental integrity and sustainable development, whereby Parties develop the specific standards. This option will contain additional disclosure provisions under Article 13 on how the ITMOs meet the standards, and require a technical peer review process. Therefore, this option is a decentralized climate change regime but has a certain binding force. Meanwhile under a centralized governance, the CMA sets out the specific standards, provides the review process, and supervises the approval, issuance and transfer of ITMOs. This option is similar to the CDM and has strong binding force.

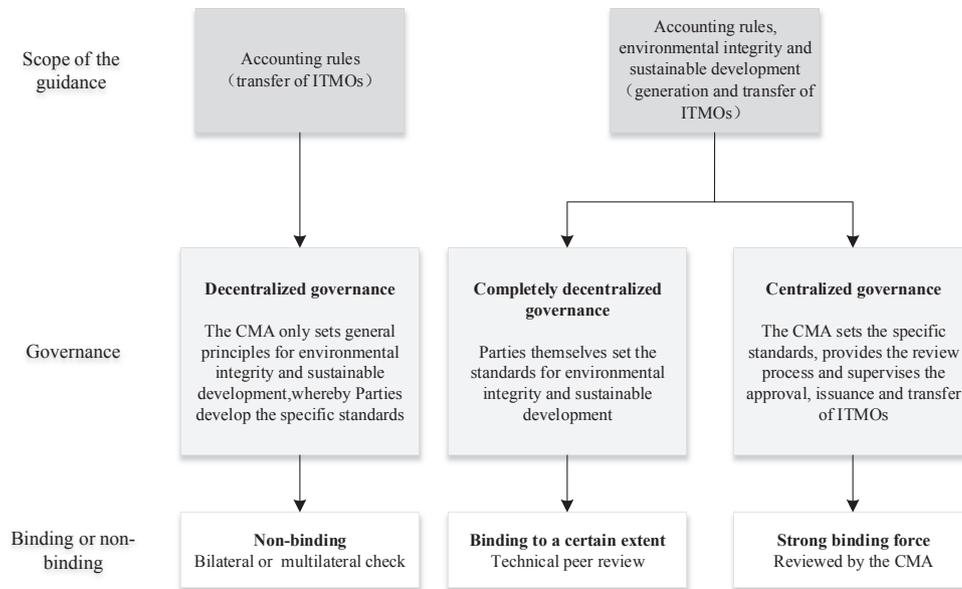


Fig. 2. The scope of the guidance and the governance of CAs.

3.1.2. Limitations on ITMOs

There are four limitations on ITMOs (Marcu, 2017c), and the first one has to do with the scope of ITMOs, specifically, whether a mitigation outcome originating from mitigation activities outside the scope of a Party's NDC could be regarded as an ITMO. Some Parties have expressed the importance of fostering ambition by allowing a mitigation outcome outside the NDC to be transferred under CAs. Other Parties, however, argue that this could result in double accounting, and would bring controversy in developing accounting rules. The second limitation is on the type of ITMOs. The first view claims that ITMOs can be any type of units that fit with the NDC of the Parties involved in the transfer in order to encourage Parties to participate in CAs actively. The second view holds that only an ITMO denominated in tCO₂ can be transferred under CAs so as to ensure compatibility and make accounting significantly easier. The third limitation has something to do with the shelf life, which refers to whether an ITMO could be banked, and if allowed, whether it needs to restrict the shelf life. The last one is about quantity, which means that Parties can only use an explicit percentage of ITMOs toward their NDCs.

3.1.3. Accounting rules

Accounting rules include the application of the corresponding adjustments if ITMOs are actually transferred between two Parties. Therefore, four issues need to be settled (Mizuno, 2017). The first issue is about what exactly should be adjusted. Basically, there are two options: (i) emission budget-based adjustments, namely, the application of corresponding adjustments to an emissions budget that corresponds to the NDC target of the country; and (ii) inventory-based adjustments, namely, the application of corresponding adjustments to the total net emissions level, as reported by the country through its emission inventory. The timing of the

corresponding adjustments is the second issue. Option one is to make the adjustments when using ITMOs to achieve the NDC. Another option is to make the adjustments at the time of transfer regardless of whether or not the buyer has used ITMOs. Moreover, most of the NDCs are determined for a single year target, which presents a challenge when transferring ITMOs. One view is that only ITMOs generated by the seller in the same year as the buyer's target year can be used. Another view holds that the mitigation outcomes generated during the NDC period could be averaged and the average number would be used toward the NDC. The third view is to accumulate the mitigation outcomes during the NDC period. Finally, there remains a controversy on whether corresponding adjustments should still be made if mitigation actions take place outside the NDC. Proponents view that doing so can avoid double counting, but opponents claim that this can actually discourage the mitigation activities outside the scope of the NDC.

3.2. Key issues on the SDM

3.2.1. Overall mitigation

Many Parties define overall mitigation as having a use of mitigation outcomes toward NDCs that is less than the actual abatement in order to achieve net decrease. Three issues on overall mitigation must be addressed (WI, 2017; Marcu, 2017a). The first issue is on the necessity of delivering overall mitigation, and the second issue regards how overall mitigation can be delivered. One approach is to subjectively define conservative baselines. A second option is to set an objective percentage. If the second option is preferred, it will have to be decided when to deliver overall mitigation. This could be done at the time of issuance, transfer, or usage toward NDCs.

3.2.2. Relationship between the SDM and CAs

Article 6 does not explicitly state the relationship between these two international carbon markets. The issue hinges on the fungibility of credits from the SDM and ITMOs (ADB, 2018). One option is that there is no fungibility and that SDM credits are never ITMOs because of the uncertainties in the environmental integrity of ITMOs. This implies the creation of a parallel transfer rules for SDM credits. Another option is that SDM credits would become ITMOs once they are transferred. Therefore, the transfer of SDM credits would be done under the same accounting rules with CAs. The third option is to consider SDM credits as ITMOs at some point. This implies that the SDM credit is not an ITMO under the first transfer, but it will become an ITMO under the second transfer.

3.2.3. CDM transition to the SDM

The transition of the CDM to the SDM is an important issue as it signals the credibility of investment in the carbon market created under the UNFCCC. The transition refers to different aspects, including CDM activities, CDM credits, and CDM rules and institutions, among which the transition of CDM activities receives great differences (CF, 2017). Some Parties are in favor of migrating all registered CDM activities directly into the SDM. However, most Parties hold that the migration of CDM activities should depend on whether or not the SDM requirements are met. Furthermore, there are different views on which CDM activities should be allowed to migrate. One view is to allow all CDM activities to migrate but with adjustments that limit how many credits can be issued. Another view is to set restrictions to choose the specific types of mitigation activities, such as allowing only migrating activities in specific regions, with specific technology types or vintages.

4. International carbon markets in China

4.1. Contributions of the international carbon markets in China

4.1.1. An effective tool for climate finance

In order to achieve the peak emission target in 2030, the climate financing demand of China must reach CN¥2.52 trillion. However, at present, the annual supply of climate funds is only CN¥525.6 billion, and the gap can still exceed CN¥2 trillion per year (Amin et al., 2014; Li et al., 2017). To fill this huge gap, public funds must be increased and private investments should be fully leveraged, and the latter can be attained through the international carbon market. The international carbon market should provide investors with a stable and clear carbon price signal so as to well function in climate finance. Therefore, the supply and demand of the post-2020 carbon market must be clarified in order to avoid the disinvestments due to the low price. The demand of the international carbon market should mainly come from three sources. First, Parties will need the international carbon market units toward their NDCs, but this part of demand is likely to be small. Although nearly half of the countries intend to use the

international carbon markets, 68% of these are developing countries that are more likely to be the sellers than the buyers (Cames et al., 2016). Second, the International Civil Aviation Organization established a global market-based measure, which requires that all emissions of international aviation above the emission level of 2020 should be offset to achieve carbon neutral growth. Currently, there are more than 70 countries involved and the demand for offsets may amount to 2.64–2.81 Gt (Cames et al., 2016; CME, 2018). Third, the demand could come from the result-based finance. Given that SDM can be used for the disbursement tool of the result-based finance, which can provide predictable payments due to its relation to the Green Climate Fund (UNFCCC, 2013). On the one hand, the host country government can obtain revenues similar to those under the CDM through the international carbon market, which can increase the public funds in climate change. On the other hand, the investors can receive predictable payments through a forward contract under the bilateral crediting mechanism. Furthermore, they can also apply the result-based project through the SDM and obtain financial support, such as through loans or guarantees, in order to alleviate the burden related to the lack of upfront investment funds.

4.1.2. Provide further emission reductions

The international carbon market can help China deepen and broaden mitigation actions in three aspects. First, it can provide more carbon price incentives for non-ETS sectors. According to estimates, by 2050, the emission reduction potential of the building and transportation sectors would reach 2.88 GtCO₂ and 2.04 GtCO₂, which are about 1.5 and 1.02 times that of the industrial sector, respectively (Dai et al., 2013). For the afforestation and forest management sector, by 2030, the emission reduction potential would be about 492–811 MtCO₂, roughly the same with the industry sector. However, none of the three sectors are involved in the national carbon market. Although the non-ETS sectors can gain carbon price incentives by applying for the voluntary emission reduction projects, the number of projects applied in these three sectors is less than 8% (Zhang et al., 2018). In addition to the complexity of methodologies in these three sectors, the other two main reasons are the low demand resulting from restrictions on voluntary emission reduction projects in the carbon market pilots and the high transaction costs embedded in the projects (Zhou and Duan, 2014). In comparison, there are less restrictions on the emission reduction projects under the international carbon markets, thus providing investors with more options for carbon price incentives. Moreover, the sectoral approach under the SDM would lower overall transaction costs, as the analysis of additionality would be done once at the sector level (Chan et al., 2016). Second, the international carbon market can broaden mitigation actions to non-CO₂ greenhouse gases (GHG). In China, the non-CO₂ GHG are paid less attention and are excluded from the voluntary ETS and the national carbon market. However, the emission reduction potential of non-CO₂ GHG must reach 800 MtCO₂ each year, among which 600 MtCO₂ must be achieved by the

fiscal subsidies or carbon price incentives (Yao et al., 2016). Therefore, the international carbon market can be used to offer economic incentives to promote the non-CO₂ emission reduction. Finally, the international carbon market could enhance the emission reduction by overcoming non-prices barriers. There is a large amount of financially viable mitigation potential, which has not been fully developed in China, implying that some non-price barriers or hidden costs exist. For example, the emission reduction potential in the non-ferrous metal industry with negative costs is 18.48 Mt CO₂ by 2020, accounting for 95% of the total emission reduction potential of this industry. In the iron and steel industry, the production of cost-effective electric arc furnace technology only accounts for 10% (much less than that in most developed countries) (Li and Zhu, 2014). In order to address these barriers, the government must implement dedicated policy measures (Sterk et al., 2015). Therefore, the climate funds from the international carbon market could offer the financial support for developing such policies.

4.1.3. Promote Belt and Road initiatives and the China South–South cooperation in climate change

The government has made clear its intention to incorporate green strategies into the Belt and Road initiatives (BRI). However, the actual investments so far have not shown a strong alignment with this ideal. From 2014 to 2017, six Chinese banks participated in syndicated loans worth US\$143 billion in 32 BRI countries, but 72% of the total syndicated loans went to the oil, gas, and petrochemical sector (Zhou et al., 2018). About 54% of the syndicated loans were used to finance fossil-fuel power plants within the electric power generation and transmission sector (Zhou et al., 2018). Therefore, redirecting China's overseas investments to low carbon areas is the key to promoting the green BRI and eliminating the negative impact of “exporting excess capacity and pollution.” The international carbon market can make a two-fold contribution in this area. On the one hand, companies and financial institutions could be directed to make low-carbon investments in the BRI countries through bilateral or multi-lateral crediting mechanisms under CAs and the SDM. The return on investment includes not only the profits of the project itself, but also the emission reductions that can be used to achieve the companies' emission reduction targets or be sold in carbon markets. On the other hand, the investments of state-owned companies strongly focus on the large fossil-fuel power generation projects, but rarely involve the relatively small renewable energy power generation projects. One reason might be that the larger projects can cover the high transaction of state-owned companies (Zhou et al., 2018). International carbon markets allow the development of the emission reduction projects at the sectoral level, and also allow the decentralized small-scale projects to be integrated in order to achieve scale advantages which, in turn, can lead to the low-carbon investments of state-owned companies to a certain extent. Moreover, as the price-based instrument, the international carbon market can contribute to the upgrading of the China South–South cooperation model in climate change. The

cooperation model can then be transformed from government-to-government material donations to the advanced technology transfer and industry export led by the companies through the international carbon market. Governments of BRI countries would be well promoted to update their NDCs with sufficient granularity and quantitative information and to identify their low carbon priorities through the international carbon market. Doing so can help provide clear signals for investors and attract more investments.

4.2. Challenges faced by international carbon markets in China

4.2.1. Impacts on registered CDM projects in China

As mentioned above, the transition of the CDM is a key issue in negotiations. Some restrictions would be set to screen specific types of CDM activities, thus implying that only activities in certain regions, with specific technology types or vintages, might be allowed to undergo migration. Currently, China owns the largest CDM market in the world, with registered CDM projects accounting for 40% of the global CDM projects. The types of registered CDM projects focus on the renewable energy and industrial gas recycling. If only activities in certain regions (e.g., Africa, the least developed countries, and small island developing states) or activities of specific types could be migrated, it would have a negative effect on the confidence of Chinese investors in the stability of the carbon pricing and result in a waste of related capacity building. Therefore, in relation to a large number of registered CDM projects, China can make suggestions in conjunction with other countries (e.g., Brazil and India) that the rules of the SDM should take these countries into account, encouraging them to choose the type of CDM to be migrated. At the same time, given that the sale of emission reduction outcomes under the SDM will have an effect on the achievement of NDCs through the adjustment of NDCs, the host country government must consider the appropriate types of the CDM to be migrated and the system to be used for regulating the sale of emission reduction outcomes.

4.2.2. Policy interaction with existing climate policies

Currently, many climate policies are implemented in China, including the command and control regulations, such as the detailed emission reduction targets at the national and provincial level, the specific requirements on local governments and companies, and the market-based instruments, such as the voluntary ETS and the national ETS. Furthermore, there is a wide range of sectoral measures on low carbon technology and energy efficiency. All these policies would interact with the international carbon market, heightening the difficulties of measurement and projection of emissions and doubling the amount of accounting tasks involved (Munnings et al., 2016; Zhang et al., 2013). In addition, these climate policies are developed by different ministries and agencies, leading to overlap, confusion, and inconsistency (Zhang et al., 2014). The policy interaction will become more complex under the SDM as the additionality must be assessed. If the emission reduction

projects take place outside the NDC, the policy interaction will have less effect on the additionality. If the emission reduction projects are developed inside the NDC, the domestic climate policies can have a direct effect on the assessment of the additionality and, in turn, affect the emission reduction revenue. Therefore, the government needs to address the compatibility of the international carbon market with other policies.

4.2.3. *Impacts on the mitigation activities outside the NDC*

Parties have argued on the scope of the ITMOs in negotiations. Some Parties believe that the ITMOs should originate from the inside of the NDC to ensure environmental integrity. This implies that China will lose the opportunity to use the international carbon market to encourage the emission reduction of non-CO₂ GHG. Moreover, if ITMOs are allowed to be generated outside the NDC, some parties claim that corresponding adjustments of the NDC should be made when transferring an ITMO. On the one hand, the transfer of ITMOs will affect the achievement of the NDC. On the other hand, this would discourage the investments in the mitigation activities of non-CO₂ GHG. Some mitigation technologies on non-CO₂ GHG cannot be implemented without the carbon price incentives. In addition, the main reason why some sectors or GHG are not included in an NDC is usually the lack of quality data (WI, 2017). The majority of climate policies and targets only focus on CO₂ in China, resulting in limited awareness on non-CO₂ GHG (Yao et al., 2016). If emission reduction projects on non-CO₂ GHG are suppressed under the international carbon market, this would have a negative effect on data availability and thereby discourage the government to integrate the non-CO₂ GHG in future NDCs. Therefore, China could recommend allowing ITMOs to be generated from the outside the NDC, eliminating the need to adjust the host country's NDC when transferring such ITMOs.

5. Development prospects of the international carbon markets in China

5.1. *Development prospects of CAs in China*

China must consider the implementation of international carbon markets at different stages of development. The bilateral crediting mechanism under CAs might be developed in the short term based on three reasons. First, there is a need to develop green BRI and upgrade the South–South cooperation model of climate change in China, which can be achieved through the bilateral crediting mechanism. Second, the government and companies have accumulated rich experience in voluntary emission reduction projects and CDM projects, thus promoting a quick start for the bilateral crediting mechanism. Third, there are many successful cases available for reference as Japan has initiated the bilateral crediting mechanism since 2010. As for the capacity building, China must identify priority cooperation countries in BRI regions, engage in feasibility studies to find potential emission reduction projects, and develop standards and methods for the measurement, reporting, and verification (MRV) activities (Le and Delbosc, 2012).

Meanwhile, consultations with local government officials and companies are required to develop capacity to implement the bilateral crediting mechanism by organizing technical seminars and workshops.

ETS linkage is not just the development direction of the international carbon market, it is also the main way for China to explore international cooperation in the carbon markets (Pang et al., 2014). In addition, the government has encouraged the exploration of the feasibility of ETS linkage (NDRC, 2014; Ewing, 2016). Given that the full harmonization of ETS at the national level has many challenges, it is possible for China to explore the ETS linkage at the regional level in the short and medium term, which would establish the basis for the linkage at the national level. The incremental linkage that focuses on “linking by degrees” is a good starting point, which allows for the tentative alignment of key design elements prior to the formal linkage (Ewing, 2016). The government is thus required to establish an information platform to enhance the transparency around MRV rules and practices that must be partially harmonized. The design of the national ETS must avoid incompatibility with other carbon markets to pursue the linkage-readiness designs, which can provide flexibility in linking with other ETS in the long term.

5.2. *Development prospects of the SDM in China*

Three factors should be considered when exploring the development prospects of the SDM in China: (i) development of the emission reduction projects at the project level or at the sectoral level, (ii) whether or not the installation level database has been established, and (iii) the relationship between the SDM and national ETS.

Developing the SDM at the project level is a good starting point as there is rich experience and expertise with project-based mechanisms in China. This approach could provide more carbon price incentives for companies and promote a quick start for the SDM. However, the emission reduction actions must be deepened and broadened in order to achieve the NDC that cannot be attained through the SDM at the project level. Therefore, the scope of the SDM must be broadened to the sectoral level in the medium term. On the one hand, the quality and quantity of emission data tend to be poor in China (Munnings et al., 2016); on the other hand, some climate policies already exist and have been proven to be effective. Therefore, strengthening these policies could be a good start for the SDM at the sectoral level. For example, the implementation of 50% reduction in design heating energy for buildings without proper insulation has already saved 31.5 MtCO₂ in 2010. If all the new buildings aim for a standard of 65% reduction, an additional reduction of 63 MtCO₂ would be realized by 2030 (Xiao et al., 2014). The government has required the key companies to report their annual GHG emissions since 2014 and issued accounting methods and reporting guidelines for 24 industries. Therefore, the installation level data will be available in the long term, making it possible to develop the SDM by setting an emission reduction target for an entire sector. Further, this target could be

decomposed into emission target for individual installation in order to provide clearer and more reliable price signal.

When it comes to the relationship between the SDM and the national ETS, there remains a need to consider the specific sector in which the SDM will be developed. If the SDM is implemented in the non-ETS sectors, there are two options: (i) the SDM in the non-ETS sectors could be used to create readiness in these sectors in order to help such sectors gradually transition to the national ETS, and (ii) the SDM in non-ETS sectors could be considered as an independent and complementary emission reduction tool for the national ETS. If the SDM is implemented in the ETS sectors, then the government can refer to the experience from the EU-ETS to introduce the SDM at the sectoral level into the national ETS, thus ensuring high dynamic and static economic efficiency.

Conflict of interest

The authors declare no conflict of interest.

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