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A Linkage Framework for the China National Emission Trading System (CETS): Insight from Key Global Carbon Markets

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Abstract: Given that international collaborative efforts to reduce greenhouse gas (GHG) emissions are urgent and crucial, a critical understanding of challenges and opportunities of linking China's newly established national ETS with existing domestic or regional ETSs is essential in order to achieve global emission targets, and may attract other jurisdictions to join in global carbon market development. In this backdrop, we analyzed the experiences, lessons, and insights from three key global carbon markets, namely North America, the EU and China, in terms of the barriers to linking the global carbon market, with a focus on China, using thematic analysis. The four most commonly cited linkage design elements (barriers) were the legal basis; monitoring, reporting, and verification; political feasibility; and the price-management mechanism. Like-minded jurisdictions with similar political views and design features will have a higher chance of linking. Additionally, sustaining market liquidity, widening sectoral coverage, minimizing carbon leakage, ensuring offset quality, and a transparent allowance and cap setting rules are crucial steps towards linkage. These outcomes can be used as an ETS linkage-ready design framework for CETS and ETS under development to overcome barriers to future international ETS linkages.

Keywords: carbon market; emission trading systems; linkage; expert opinion

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1. Introduction

Climate change increasingly threatens our environment and society. International collaborative efforts to reduce greenhouse gas (GHG) emissions are urgent and crucial to this global issue. Emission trading systems (ETS) and their linkages at the national and sub-national levels have become a global strategy to address the 1.5 °C target set by the Intergovernmental Panel on Climate Change (IPCC) [1]. Carbon ETS linkage improves market liquidity, reduces price volatility, enhances the system's credibility, and, most importantly, motivates actors to meet the emission reduction targets more efficiently [2,3]. Additionally, ETS linkages can increase the economic aggregate, broaden ambitious emission goals, and reduce carbon leakage issues in some jurisdictions [4,5]. The scope of ETS linkage become even more important due to historic Paris agreement Article 6.2, which provides the foundation for linkage by recognizing use of "internationally transferred mitigation outcomes (ITMO)" in parties' NDC to achieve their NDC target [6–8]. Indeed, about two thirds of the parties' NDCs, representing 58% of global emission, considered using carbon pricing to achieve their NDC target [9]. Such international linkage is estimated to

reduce the cost of achieving the emissions reduction specified in the initial set of NDC by 32% by 2030 and by 54% by 2050 [7].

In Europe, the EU ETS was implemented in 2005, comprises 31 [10] member states and is linked with the Swiss ETS, which started on 1 January 2020 [11]. In North America, the California cap-and-trade program has been linked with Quebec's cap-and-trade system since 2014, and both have been linked with the Ontario ETS since 2018 [12]. The Regional Greenhouse Gas Initiative (RGGI) consists of 10 northeastern US states and began operating in 2009. The Pennsylvania ETS will link with the RGGI in 2022, and the Virginia ETS is also in the process of establishing an ETS and linking it to the RGGI program [11]. In Asia, the Tokyo ETS has been linked with the Saitama ETS since April 2011 [11]. China established seven ETS pilots beginning in 2013 to fulfill the 12th Five-Year Plan [13] and planned to implement the National ETS (CETS) by mid-2021 with full operation during the 14th Five-Year Plan (2021–2025) to fulfill its commitments [14].

As China is the largest carbon emitter globally and establishment of national ETS, the linking of its CETS with international ETS would have considerable global benefits in terms of reducing global carbon emission and achieving the Paris Agreement goals [11]. A model has shown that linking the CETS with the EU ETS would reduce carbon emissions by an additional 169 million tons compared to each one operating independently while keeping the threshold level of welfare above zero [4]. Similarly, a Northeast Asia regional ETS cooperation has become increasingly feasible under the Paris Agreement compared to the Kyoto Protocol [15]. Due to high compatibility in technical capacity and geographic proximity, there is enormous potential for the linkage between the CETS and Korean ETS and the upcoming Japanese National ETS [16].

Although ETS linkages have countless opportunities to reduce global GHG emissions, barriers and challenges also exist [2,17]. Most of the existing ETS literature has either focused on analyzing the relevant policies and quantitative emission data from the ETS pilots and identifying the critical challenges for the CETS [18–20] or utilizing the experiences of international jurisdictions [21–23] to provide recommendations for the CETS establishment. However, few researchers have provided guidance for the linkage-readiness design of the CETS [24], and those studies were mostly based on literature reviews. Additionally, very few researchers have collected primary qualitative data from global experts using well-structured interview questions related to ETS linkage. A critical understanding of the future linkage challenges and opportunities of ETS is essential in the design stage [24,25]. Learning lessons from established linked systems such as the North America and EU ETSs is crucial for the CETS to consider future international linkage. Against this backdrop, this paper qualitatively investigates the challenges, perceptions, and attitudes towards ETS linkage by interviewing local experts from the three key global ETS: the EU, the California, Quebec, and Ontario cap-and-trade systems (North America), and the Chinese ETS pilots. By integrating the qualitative analysis results with the published literature and documents, this paper seeks to provide a design guideline that helps the CETS and other systems overcome barriers to linking ETS in international jurisdictions in the future.

2. Material and Method

2.1. Study Area, Interview and Interview Questionnaires

This study is part of a larger research project investigating carbon market systems' status to facilitate linkages between the currently developing Chinese national carbon market and the international carbon market. We interviewed 15 experts directly involved in the three main global cap-and-trade markets: the EU ETS ($n = 3$), the North American ($n = 7$) ETS linkages (California, Quebec, and Ontario), and five Chinese ETS pilot markets ($n = 5$) (Beijing, Shanghai, Hubei, Guangdong, and Shenzhen) using open-ended questionnaires to cover key topics related to barriers of linking the Chinese ETS with respective ETSs (Figure 1). Based on current qualitative research thinking, our participants provided us a significant amount of diverse information needed to address the research questions. Hence,

this (sample size of our qualitative research) satisfies the number of participants, which require 6–9 interviews to reach topic saturation for qualitative research [26].

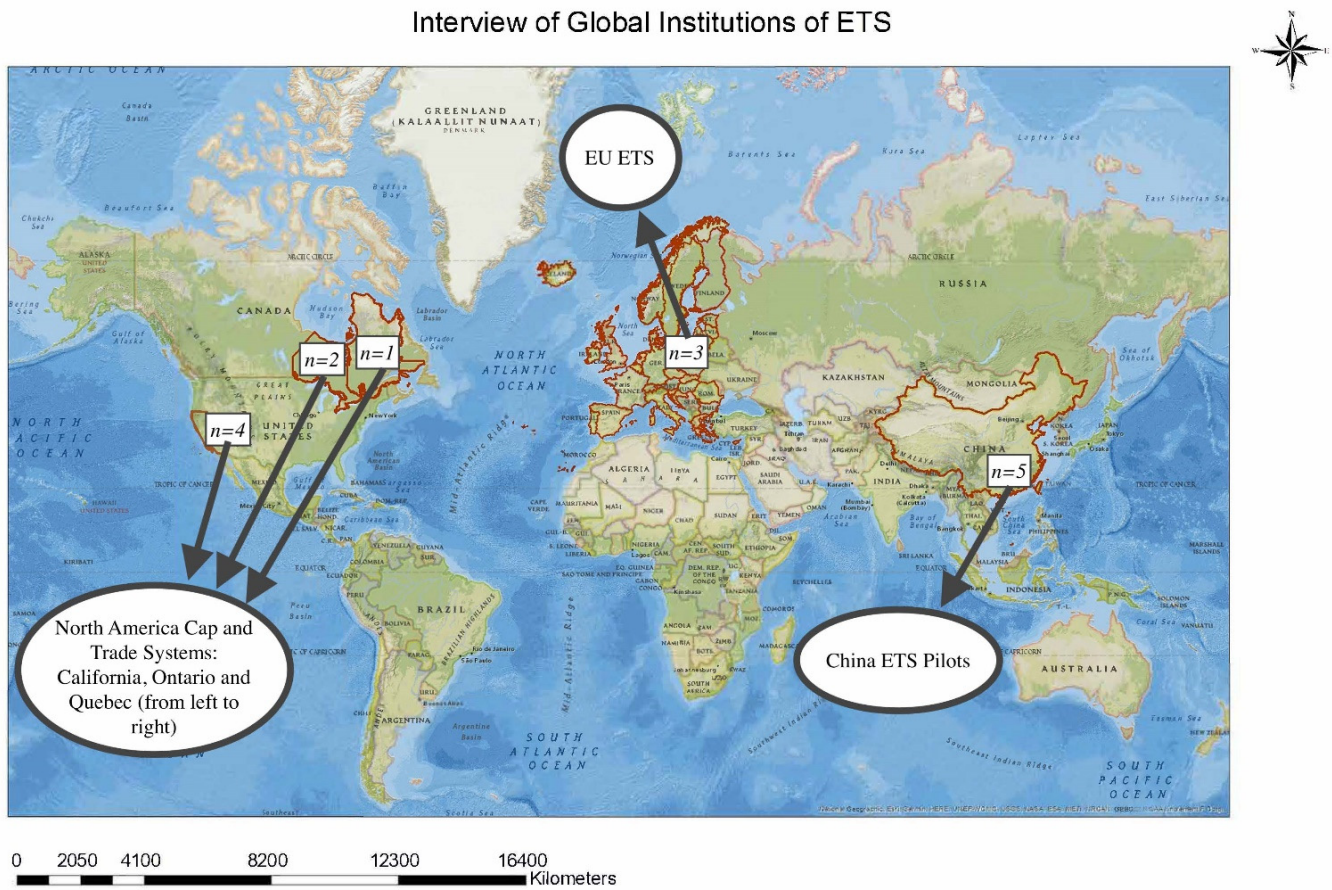

Figure 1. The locations of the studied ETS institutions and the number of experts interviewed.

For the interview, we contacted the relevant carbon trade institution in the related jurisdiction, requesting their interest in participating in our research and selecting the experts. The respective organization recommended its representative, and then we set up an in-depth interview with the experts. Hence, experts' opinions represent not only their knowledge and experience but also that of their affiliated institutions. The first three parts of the interview questions included the status of the current ETS, challenges and successes of local ETS, and experiences with current ETS linkages, whereas part four questions related to their perspectives of the linkage to international carbon markets. All the interviews were audio-recorded and transcribed using NVivo.

2.2. Coding and Thematic Analysis

We coded all interviews to identify key themes and perspectives associated with barriers (design elements) to linking ETS through a six-phased thematic analysis (TA) conducting trustworthy TA research based on the primary interview data in the NVivo (12) to develop a CETS linkage-readiness design elements framework [27]. The design elements in this study were defined as the essential elements that the CETS needs to develop in the framework with the linkage perspective.

In phase I, we transcribed the recorded interview data into word documents to ensure their compatibility with NVivo. We repeatedly read and immersed ourselves in all the texts to better familiarize ourselves with the data, and then created a thematic network (Figure 2).

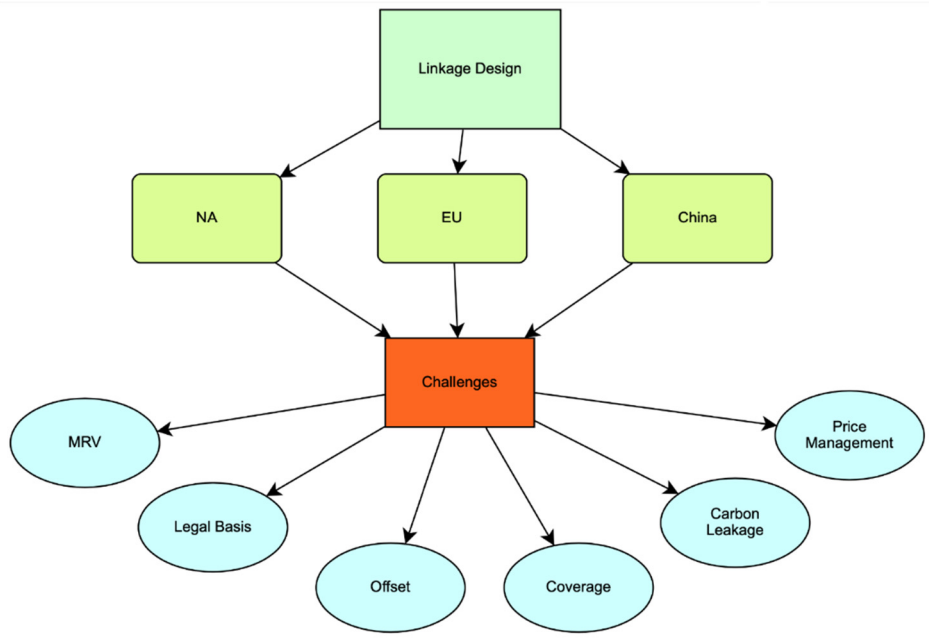

Figure 2. The thematic network developed during phase I of the TA. Figure generated in NVivo 12 (NA—North America, EU—European Union).

We used the deductive approach for phase II to III to generate codes and search for themes. In a deductive approach, the contents are coded from the top-down if the researchers understand the concepts and ideas [28]. We consistently referred to the thematic network during the coding process since a thematic network serves as the foundation to explore themes [29]. After several peer debriefings and revisions, we deductively derived a thematic coding framework within NVivo (Figure 3a), which included the design features and design considerations. During phase IV, our team decided to delete or merge the overlapping themes. We merged the design features and design considerations into the design elements to fit the network better. We also changed the "political compatibility" to "political feasibility" to better align with the nodes. Moreover, we deleted the node "revenue earmarking" because only two sentences were coded to this node, and the data were inconsistent with our research question. A concise thematic framework for the CETS linkage design was developed (Figure 3b), and we subsequently merged the three jurisdictions to analyze the overall trend (Figure 3c). We analyzed and scrutinized all the interview transcriptions during phase V by confirming and finalizing the thematic framework, as depicted in Figure 3b,c. In phase VI, we used Microsoft Excel in conjunction with NVivo for data preparation and further analysis using the existing literature [30,31].

2.3. Relative Frequency Analysis

We recorded the total number of references for each node, representing the design element reported by each expert, in the thematic network as frequency, and calculated the relative frequencies (%) by dividing the individual frequency of each node with the total frequency of all the nodes. We also calculated the relative frequency (%) of the design elements for each jurisdiction.

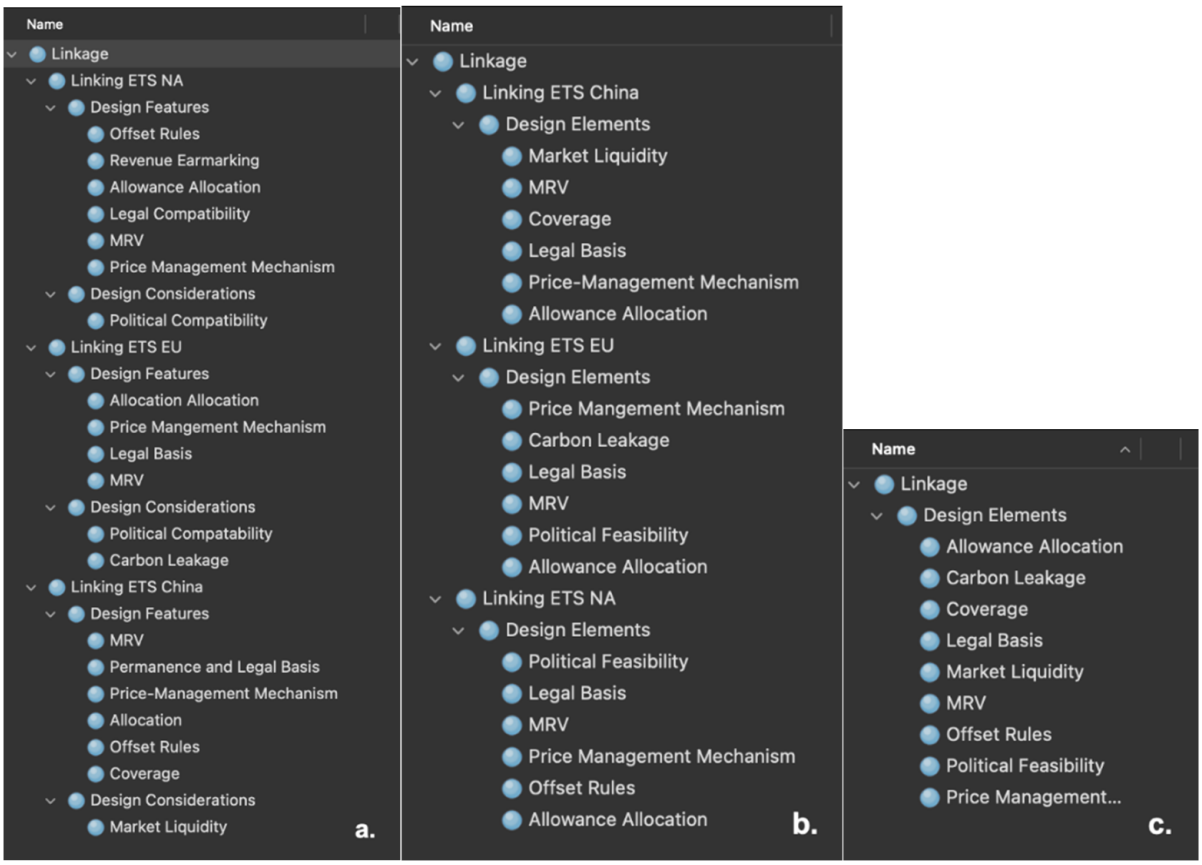

Figure 3. The coding framework generated during phase II to III (**a**); screenshot of the coding framework updated in phase IV (**b**); and screenshot of the coding framework after merging the three jurisdictions (**c**).

3. Results

The legal basis, monitoring, reporting, and verification (MRV), political feasibility, and price-management mechanism were the most frequently discussed design elements for market linkage readiness (Table 1). The frequency of these elements ranged from 18 to 27. The number of experts that discussed these four elements ranged from 10 to 11. Fewer experts mentioned the remaining elements with lower frequency.

Table 1. The frequency of the design elements and the number of experts discussing the elements.

Design Elements	Frequency	Number of Experts
Legal Basis	27	11
MRV	26	10
Political Feasibility	25	10
Price-Management Mechanism	18	10
Market Liquidity	9	5
Coverage	7	3
Carbon Leakage	5	3
Offset Rules	4	2
Allowance Allocation	3	3
Total	124	57

The legal basis, MRV, political feasibility, and price management comprised more than three-quarters of the total responses (Figure 4). Market liquidity, coverage and carbon leakage exhibited moderate relative frequency, whereas the offset rules and allowance allocation had the lowest relative frequencies (Figure 4).

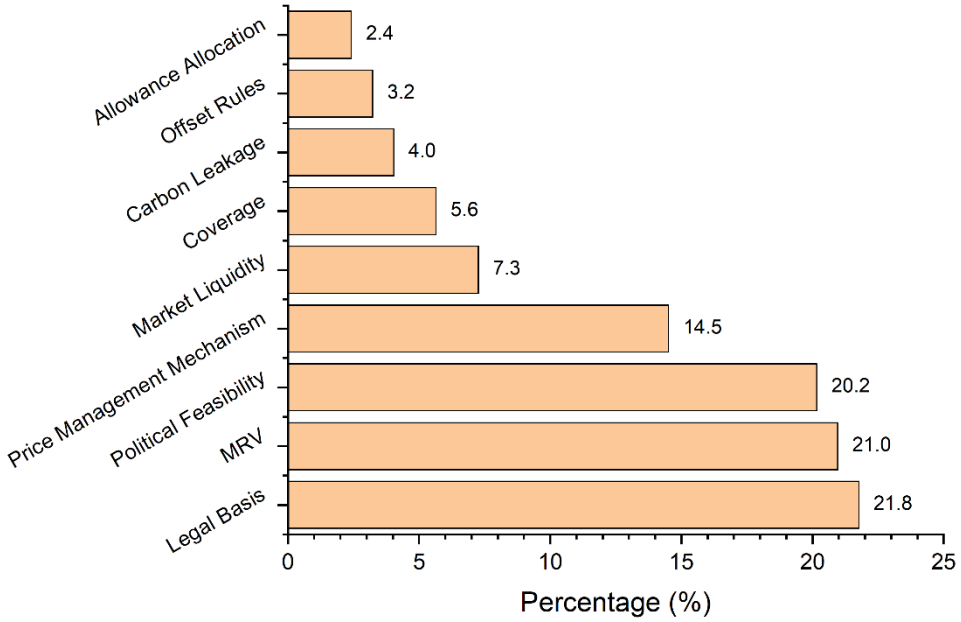

Figure 4. Relative frequency (%) of design elements reported by experts from three jurisdictions.

The NA experts focused more on the political feasibility and legal basis, whereas the EU experts emphasized the price-management mechanism, among the four elements (Figure 5). In contrast, the Chinese experts focused on the MRV. Market liquidity and coverage were only discussed by Chinese experts, carbon leakage was of interest only to EU experts, and the offset rules were solely discussed by NA experts. The offset rules and allowance allocation were the least discussed points throughout the entire interview. However, allowance allocation was an element of interest for the experts from all three jurisdictions.

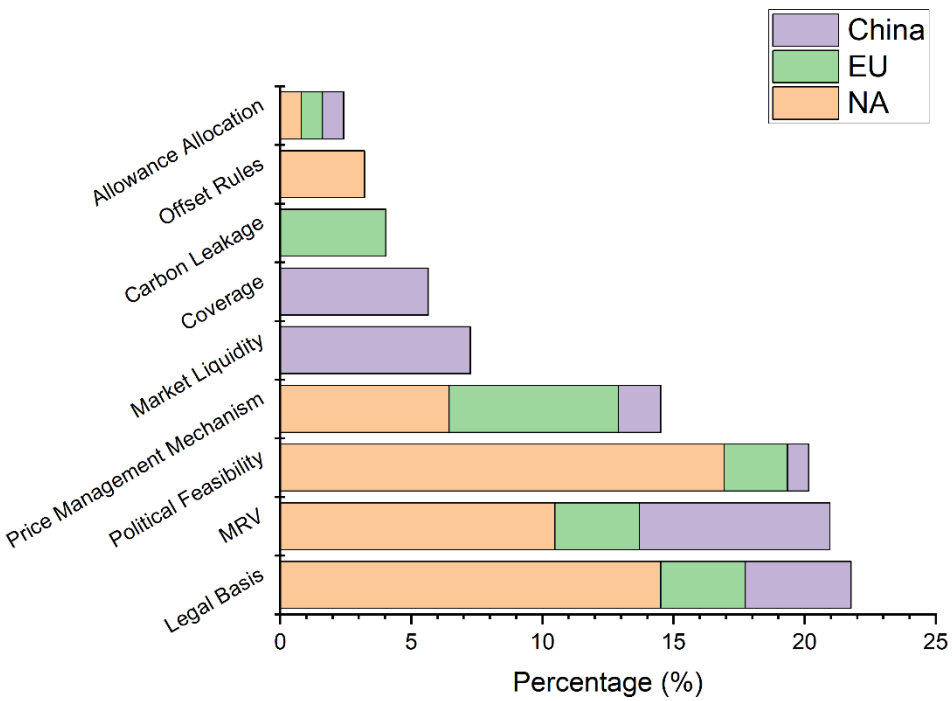

Figure 5. Relative frequency (%) of the design elements reported by each jurisdiction.

4. Discussion

This paper investigates ETS linkage challenges, particularly design elements based on experts' experience in three major cap-and-trade systems. First, we discussed challenges in design elements commonly expressed by the experts from all the three jurisdictions (common design element) followed by challenges unique to each jurisdiction (unique design element), including essential design elements for the CETS' linkage-readiness framework to overcome the barriers to future international ETS linkages.

4.1. Common Design Elements

4.1.1. Legal Basis

The experts from the three jurisdictions stated that a clear legal basis for ETS participants would enhance the permanence and predictability of the linkages. Each ETS must be built upon a robust legal foundation that provides authority to link with a foreign jurisdiction, and the authority to implement appropriate linking regulations, including the role and status of emission allowances, compliance obligations, trading rules, monitoring, reporting and verification principles, and the basis for penalties for noncompliance or infringements [32,33]. A lack of compatible legal frameworks could be a barrier to authorizing necessary interlinkages, including the safeguarding of their operation, and this might prevent an executive agency from linking its ETS with a foreign jurisdiction's ETS. The NA experts further emphasized that the legislation should ensure the system's ability to align foreign policies seamlessly, since uncertainty about the legal basis and its inter-compatibility would deter regulatory linkages. For instance, in California, the CARB-enacted Senate Bill 1018 secured potential linking opportunities with other jurisdictions, including those in the Canadian Provinces [12]. Similarly, in Europe, the EU ETS is part of the European environmental legislation [10]. The European Commission is responsible for implementing the EU ETS legislation and has the authority to link within their system and impose penalties on violating member states [10].

On the other hand, the Chinese experts pointed out a lack of relevant supporting legislation for either pilots (except for Shenzhen ETS) or nationwide ETS, resulting in a low willingness to comply with intense carbon-emitting enterprises and a low chance of linking with other jurisdictions. For example, the Chinese pilot ETS has diverse rules for non-compliance with low penalties; therefore, it lacks effective policy tools and ability to address compliance and enforcement [32]. China's ETS pilots are well-developed but still lack the ability to link with other international sub-national ETS unless the relevant legislation is passed [32]. The Chinese experts also pointed out that legislation is the key to a successful national ETS and is the foundation for realizing potential market linkage, in line with Liu et al. [19] and Townshend et al. [34]. However, the related legal provisions for market linkage are still lacking in the newly published draft CETS Regulations [35]. The inclusion of linkage provisions in the legislation is critical for CETS to gain the most mutual compatibility [36]. Such provisions could include criteria, conditions and restrictions for market linkage, which help CETS to prepare for negotiation with international ETS linkage [32]. Even if no linkage has been proposed yet, a robust legal framework with clear status of emission allowances, compliance obligations, trading rules, MRV principles, and the basis for penalties for non-compliance will facilitate more linkage opportunities as there is no universally standardized linkage-ready legal basis and regulations [37].

4.1.2. Monitoring, Reporting, and Verification (MRV)

The experts from the three jurisdictions emphasized the importance of transparency of the MRV processing of emission data, which would be reported after ETS linkage. The NA experts stressed that some Californians were questioning the validity of emission data in foreign nations such as China due to a lack of data inventory transparency. The EU experts argued that even a minor tolerance of non-transparency could lower credibility. Market linkage could be deterred by inadequate data credibility. The EU ETS specifies that all data collection and flow must be transparently documented [38], while the CARB enforces

market surveillance analysis for transparency and accuracy of the MRV. In addition, case settlements are publicly accessible [39]. On the other hand, the Chinese experts recognized that the reports were not transparent in Chinese pilot projects in the past, and argued that the CETS urgently needs to improve market information transparency. For instance, the disclosure of strategic information of covered entities such as fuel consumption, emission data and allowance ownership or trading activities is protected from informed public access [33]. The NDRC shares market information only with market actors and the regulators [33,40]. The lack of such information will lead to ineffective participation and less confidence from participating jurisdictions in linking ETS due to reliability of the partners' policy [41,42].

The Chinese experts noted an urgency for appropriate verification processes, either a third-party verification team or a national verification agency, to demonstrate the validity and the strength of the carbon market. The verification mechanisms are not uniform in the ETS pilot projects; some pilots have specific verification rules, whereas others rely on third-party verifications. These conditions can lead to significant perceived inequities in a national carbon market [19]. In addition, the verification mechanisms in China are not efficient enough for the volume of national emission levels. Liu et al. [19] pointed out that enterprises cannot obtain the required verification information in time. Moreover, the experts from the Chinese pilot projects emphasized that a practical and functional electronic information system is vital for MRV. These responses are consistent with the findings of Tang et al. [43]. The level of use of information technology is low and uneven among ETS pilot projects. An MRV system based on information technology enhances the efficiency and integrity of the market since it requires and enables transparent monitoring plans, assessments of reports, and verifications.

Given that a robust MRV system design—containing stringent but transparent procedures—is the very foundation for international linkage [32], emerging ETSs, such as the CETS, are recommended to consistently invest in capacity-building of MRV to maximize the compatibility and feasibility of linking, because the newly established ETS is often short of capacity [32]. Moreover, the regular revision for MRV can facilitate the likelihood and readiness to linkage as the MRV systems are not globally uniform, and there is always room for improving the robustness [24]. Though the MRV measures and provisions are not required to be identical upon linkage [44], common or at least similar verification methods and report standards should be in place to build confidence and guarantee the sustainability of mitigation outcomes reported in a common or linked registry [33]. Additionally, setting up capacity of joint MRV institutions based on the international framework of linkage and MRV can address MRV issues and build confidence among the partner jurisdiction [33].

4.1.3. Political Feasibility

Political feasibility is a hindering factor since opposing political systems may prevent robust market linkages. The NA experts stressed that the attitudes toward carbon market linkages depend on a country's leader. After US President Donald Trump decided to opt out of the Paris Agreement for reasons relating to economic disruption, several states with linkage potential joined the climate denial movement. Therefore, the prospect of linking ETS depends on leader/government's policy regarding achieving or not achieving long-term climate mitigation goals compared to meeting leader/government's short-term domestic policy objectives [45]. Moreover, the experts emphasized that political differences between states and provinces are often barriers to linkage. In Canada, the province of Ontario withdrew from the California–Ontario–Québec cap-and-trade market after a change in political leadership in 2018 [12]. The EU experts noted that politics could delay market linkages. The EU ETS had planned to link with Switzerland, but the linkage has been on hold for political reasons for several years. It took almost five years for the Swiss ETS to link with the EU ETS [11]. Linkage between Australian ETS and EU ETS did not materialize due to political changes in Australia indicating how a polarized political environment and societal opposition to climate policy, which contributed to the failure of a prospective linked carbon market [46].

The NA respondents also pointed out that regions with existing political coalitions tend to link their ETS. For instance, Ontario, Quebec, and California are members of the Western Climate Initiative (WCI) associated with carbon trading markets. Therefore, like-minded jurisdictions with similar political views may have a higher chance of linking. The experts from China also stated that politics are a significant barrier, but linkages with jurisdictions with similar geographic proximity, such as South Korea and Japan, are promising even though they have political differences. This result is consistent with the findings reported by Arimura [16]. Hence, in addition to the political feasibility, geographic proximity can also play crucial role for developing regional ETS linkage. In this context, it is practical for CETS to gradually scope the linkage with regional partners in advance, allowing enough time to build harmonization; there could be a transition period from partial linkage to full linkage [45]. Additionally, linking one jurisdiction first and adding the other one later could cost less than linking all three together, learning from the West Coast Initiative (WCI) [45].

Another political issue related to linking ETS may arise from the likely foreign control and loss of autonomy over some aspects of its domestic carbon market policy during the negotiation for linkage, thus influencing the government/leader's decision on the ETS linkage [7,45]. In addition, there is always the threat of opportunistic behavior from a partnering government/entity, in which they can unilaterally impose a regulatory risk, such as imposing fees or quotas on cross-border permit transactions, providing exemptions to previously regulated entities, or terminating the arrangement [45]. Therefore, a government/leader's decision on linking is influenced by the relative cost and benefits of linking for achieving long-term climate mitigation goals, while at the same time meeting domestic policy objectives in the short term [47]. Political willingness is a key for a successful linkage.

4.1.4. Price-Management Mechanism

The ETS linkage can provide the benefits of increasing market liquidity and reducing price volatility. The experts from the three jurisdictions stated that the lack of a price-management mechanism for allowances could be considered a barrier to market linkages. The NA and EU experts emphasized that price stability was the mirror of ETS's additionality and validity. For example, the additionality of the EU ETS was negatively affected by the collapse of the EU market price due to the oversupply of allowances since 2009. This phenomenon of "hot air" was owing to the inappropriate allowance distribution of the Kyoto Protocol, which surpassed the threshold for causing market inefficiency [48,49]. As a result, few ETS markets were interested in linking with the EU ETS at that time [11]. Hence, the enforcement of price-management tools should be considered for market linkages.

The Chinese experts recognized that the carbon price was neither optimal nor consistent in all pilots, affecting the overall stringency. For instance, the carbon price of the Shanghai pilot project fluctuated at 4–5 RMB from 2015–2016, and the price fluctuated substantially in the Beijing pilot project. The experts stressed that the unstable and non-optimal pricing of the pilot projects required a transition time for the CETS to achieve a single price and future linkage. Both the EU ETS and the California and Quebec cap-and-trade have stable pricing, namely, EUR 27.10 (7 October 2020) and USD 16.69 (August 2020), respectively [50]. The NA and EU experts suggested that price-management mechanisms, including a price floor, price ceiling, market stability reserve, and a stable price set by the market mechanism, are essential to balance the market function and achieve market linkage. The California cap-and-trade program has implemented a price floor, and the Allowance Price Containment Reserve acts as a price ceiling [51]. A carefully designed price floor is a price-management mechanism that can prevent price volatility and enhance price stability and predictability. It can also be used in conjunction with a price ceiling to manage price fluctuations [52]. Moreover, the EU ETS proposed a market stability reserve mechanism after 2021 in phase four. The mechanism controls and adjusts the supply of the allowances responding to the demand; hence, there will be no surplus, and the market will be resilient to shocks [53].

4.1.5. Allowance Allocation

All experts believed that the clarity and transparency of allocation rules are essential for the CETS to link with the international ETS. The EU experts explained that other jurisdictions would stop considering linkages if the CETS was not transparent regarding the allocation rules. In contrast, the NA experts emphasized that a transparent design of the allocation rules with a clear timeline was crucial for market linkages. The EU ETS has precise and transparent rules stating that the power generation sectors are subject to auctioning, while non-power sectors obtain free allowances; the proportion of free allowances decreases over time [10]. Similarly, the CARB transparently listed the allowance structure, electrical distribution utilities, industries, and natural gas suppliers [54], and the Quebec cap-and-trade program also published the calculation method for determining the free allowance [55]. The transparency of the allowance allocation also helps enterprises improve the interpretation of the emission goal and develop plans for reducing future emissions and overall price transparency. If the allowance allocation guidelines are publicly available, researchers can provide more valuable suggestions [56], and companies can better estimate supply and demand over time and act accordingly.

Experts from NA and EU addressed the importance of setting an allowance cap for linkage readiness, since it reflects jurisdictions' motivation and ambitions. It should be noted that fixed caps often fail to adapt to the changing nature of the market, and therefore, flexible caps are recommended [57]. The European experts recommended that the CETS should revise the cap shortly after every transaction period to determine the appropriate cap and express the readiness to link. In contrast, the NA experts consistently recommended that the CETS should have a firm cap first and then flexibly decrease it year by year to reach emission reductions. The CARB stipulates that the cap should be reduced by 4% annually from 2020 to 2030 [58]. A flexible cap setting that reflects regional development differences can help reach the emission targets more efficiently, because the underdeveloped provinces do not lose with a more generous cap, and rich provinces still gain from a tight cap [59]. It is also more realistic to set the cap flexibly with adjustments based on sound historical emission intensity data [60,61]. Qi and Cheng [62] also proposed this bottom-up flexible adjustment approach. In the development stage, the entities should report their emission data with verifications in a bottom-up direction, and the provincial and national governments should set the caps afterwards. After years of adjustment and development, the national ETS will enter the mature stage and set the emission cap in a top-down direction.

4.2. Unique Design Elements

4.2.1. Market Liquidity

The Chinese experts raised market liquidity issues since the liquidity of all pilot projects in China was very low, as also reported by Munnings et al. [63]. Maintaining liquidity at the appropriate level was considered a prerequisite for international linkage. The experts stated that a market with sufficient liquidity ensures market functionality, and motivates the participants to trade actively; in turn, the participants' enthusiasm will affect the liquidity, as reported by Charles et al. [64] and Hua and Dong [65]. Additionally, the Chinese experts also stressed that higher market liquidity could increase the system's market efficiency, consistent with Ibikunle et al. [66]. Moreover, Zhao et al. [67] argued that the key to improving market efficiency is using well-chosen ETS design elements, including the legislation basis, price control, allowance allocation, and MRV, as discussed in the other sections. The experts also argued that linking all pilots and provinces to the CETS and linking the CETS with international ETS could help resolve low market liquidity, consistent with Erdmann et al. [68]. Thus, the establishment of a fully operational CETS, which will enhance market liquidity, is viewed as essential.

4.2.2. Coverage

The sectoral coverage of the ETS pilots has not been adequate. The Chinese experts explained that enterprises that should be reducing emissions did not recognize the climate change problems. Hence, there was a disincentive to participate because they were not forced to trade. Sectoral coverage should be sufficiently broad to include significant sources of carbon emissions that overlap with the similar coverage of foreign systems, hence providing more linkage opportunities. For instance, currently, electricity is the central sector participating in the pilot ETS. In contrast, all other sectors with a significant source of carbon emissions, including the steel and cement industries, are left out, thus playing minor roles in achieving ETS goals to reduce GHG reduction [69]. In contrast, most GHG-intensive sectors, including industries and electricity, are covered in the California and Quebec cap-and-trade program [54,70] and the EU ETS [10]. Coverage of more GHG industries and sectors in China will produce a more stable and effective trading environment [69], significantly reducing the abatement cost of carbon dioxide needed in order to reach climate mitigation, although there will be a moderate level of economic sacrifice [71,72]. In line with this, the China national ETS market is suggested to include mining, paper and printing, processing of petroleum, coking, processing of nuclear fuel, metals and nonmetal products, and production and supply of electric power and gas [71].

4.2.3. Carbon Leakage

The EU experts stated that carbon leakage was a barrier encountered in the EU ETS development. They expressed that carbon leakage potentially increases global GHG emissions and impacts the EU ETS's validity. Thus, mechanisms that ensure minimal carbon leakage are essential before international market linkage can be established. However, they also pointed out that linking ETS likely reduces the risk of carbon leakage between the two linking jurisdictions, providing a similar playing field for the jurisdictions involved. The EU experts further reported that the key to resolving carbon leakage issues is targeting sensitive enterprises and industries and allocating free allowances. Therefore, the enterprise will remain in the market at an acceptable cost and start to reduce emissions, as reported by Jegou and Rubini [73]. In the EU ETS, the commission allows highly leakage-risky industry sectors to receive a full free allowance to compensate for the added cost, and the remaining industry sectors will have to bear a decrease in the free allowance proportion [10]. Although not explicitly expressed by the Chinese experts, carbon leakage is also a concern for the CETS [74]. The free quota allocation for the most sensitive entities has been proposed as an essential policy instrument for managing carbon leakage risk, and excess free quotas may be distorting the market by inducing over-compensation. To address this issue, CETS should not provide full free allowance to any sector and develop a unified standard to assess the leakage risk that should be regularly revised [75]. They further added that allocating 9% of the total quota for free is sufficient to eliminate most of the carbon leakage risk in their modelling studies.

4.2.4. Offset Rules

The NA experts raised concerns about the integrity of offset programs, particularly the offset quality, when developing linkages with another jurisdiction. They stated that the California compliance offset is of high quality; hence, there is a reluctance to use other low-quality offsets outside of the California and Quebec scheme. Around 2012, China established the Chinese Certified Emission Reduction (CCER) to focus more on the national-level ETS [76]. Therefore, the quality and validity of the CCER are highly essential for CETS linkage readiness. The CCERs must be validated and verified by third parties, and strict processes should be implemented before a valid CCER enters the market [76]. Moreover, the NA experts discussed their concerns about the offset market's supply and demand because the market grows after the linkage. The total demand from more entities may exceed the supply after the linkage; the offset price would be significantly lowered, threatening market functions. Controlling the offset limits could manipulate the market

demand [77]. The offset limits used in the Chinese pilot projects range from five to ten percent of the initial allowance or of actual emissions [78]. Li et al. [79] found that the CCER reduced the costs of climate mitigation in China regarding emission reduction and argued that China's maximum offset limit should be less than six percent to avoid surpassing the equilibrium allowance price.

5. Conclusions

This paper investigated the challenges, perceptions, and attitudes toward ETS linkage by interviewing 15 local experts in three major cap-and-trade systems. The global experts highlighted four essential design elements for the CETS's linkage-readiness framework: the legal basis, MRV, political feasibility, and price-management mechanism. First, a clear legal basis should be provided to lay a foundation for international linkage. Second, consistent and transparent data reporting and a fair verification process are essential for MRV. Moreover, linking with systems in a jurisdiction with a political partnership or similar political views is also critical. Ensuring the operation of an appropriate price-management mechanism is imperative before implementing linkages. This paper also identified five additional elements essential to the design guideline, although the experts discussed these elements less frequently. The CETS has to implement mechanisms to sustain market liquidity, widen the sectoral coverage compatible with other jurisdictions, and minimize carbon leakage before global linking. Additionally, the CETS should ensure the quality and validity of the CCER and explicitly set the offset credit limits to maintain the market functions. Lastly, the CETS needs to set transparent allocation rules and a flexible cap-setting mechanism to be linkage-ready. This nine-element guideline contributes to the development of global ETS linkage since it facilitates identifying and emphasizing the critical design elements for policy designers. The CETS and other ETSs under consideration could use this guideline as a reference to overcome the barriers to future market linkages.

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References

1. IPCC. *Global Warming of 1.5 °C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*; IPCC: Geneva, Switzerland, 2018.
2. Flachsland, C.; Marschinski, R.; Edenhofer, O. To link or not to link: Benefits and disadvantages of linking cap-and-trade systems. *Clim. Policy* **2009**, *9*, 358–372. [CrossRef]

3. Doda, B.; Quemin, S.; Taschini, L. *A Theory of Gains from Trade in Multilaterally Linked ETSs*; GRI working papers 275; Grantham Research Institute on Climate Change and the Environment, London School of Economics: London, UK, 2016.
4. Li, M.; Weng, Y.; Duan, M. Emissions, energy and economic impacts of linking China's national ETS with the EU ETS. *Appl. Energy* **2019**, *235*, 1235–1244. [CrossRef]
5. Qi, T.; Weng, Y. Economic impacts of an international carbon market in achieving the INDC targets. *Energy* **2016**, *109*, 886–893. [CrossRef]
6. UNFCCC. *Paris Agreement, Article 6*; UN: Paris, France, 2015; pp. 7–8.
7. Mehling, M.; Metcalf, G.E.; Stavin, N.R. Linking climate policies to advance global mitigation. *Science* **2018**, *359*, 997–998. [CrossRef]
8. Mehling, M.A.; Metcalf, G.E.; Stavins, R.N. Linking Heterogeneous Climate Policies (Consistent with the Paris Agreement). *Environ. Law* **2019**, *8*, 647–698.
9. World Bank. *Ecofys; Vivid Economics. State and Trends of Carbon Pricing 2017*; World Bank: Washington, DC, USA, 2017.
10. European Commission. EU ETS Handbook European Commission. 2015. Available online: https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf (accessed on 22 October 2020).
11. International Carbon Action Partnership (ICAP). *Emissions Trading Worldwide: Status Report 2020*; International Carbon Action Partnership: Berlin, Germany, 2020.
12. California Air Resources Board. Program Linkage. 2020. Available online: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/program-linkage (accessed on 22 October 2020).
13. National Development and Reform Commission. Notice of the General Office of the National Development and Reform Commission on the Pilot Project of Carbon Emission Trading. 2011. Available online: https://www.ndrc.gov.cn/xxgk/zcfb/tz/201201/t20120113_964370.html (accessed on 22 October 2020). (In Chinese)
14. Carbon Emission. 2019–2020 National Carbon Emission Trading Quota Setting and Distribution Implementation Plan (Power Generation Industry). Available online: http://www.tanpaifang.com/zhengcefagui/2020/090173623.html (accessed on 22 October 2020). (In Chinese)
15. Chung, S.Y. *Political Economy of Carbon Market Cooperation in Northeast Asia. Carbon Market Cooperation in Northeast Asia: Assessing Challenges and Overcoming Barriers*; Asia Society Policy Institute: New York, NY, USA, 2018.
16. Arimura, T.H. *The Potential of Carbon Market Linkage between Japan and China. Carbon Market Cooperation in Northeast Asia: Assessing Challenges and Overcoming Barriers*; Asia Society Policy Institute: New York, NY, USA, 2018.
17. Wråke, M.; Burtraw, D.; Löfgren, Å.; Zetterberg, L. What Have We Learnt from the European Union's Emissions Trading System? *Ambio* **2012**, *41*, 12–22. [CrossRef]
18. Duan, M.; Zhou, L. Key issues in designing China's national carbon emissions trading system. *Econ. Energy Environ. Policy* **2017**, *6*, 55. [CrossRef]
19. Liu, L.; Chen, C.; Zhao, Y.; Zhao, E. China's carbon-emissions trading: Overview, challenges and future. *Renew. Sustain. Energy Rev.* **2015**, *49*, 254. [CrossRef]
20. Zhang, D.; Karplus, V.J.; Cassisa, C.; Zhang, X. Emissions trading in China: Progress and prospects. *Energy Policy* **2014**, *75*, 9–16. [CrossRef]
21. Jotzo, F.; Löschel, A. Emissions trading in China: Emerging experiences and international lessons. *Energy Policy* **2014**, *75*, 3–8. [CrossRef]
22. Liu, X.; Shen, B.; Price, L.; Hasanbeigi, A.; Lu, H.; Yu, C.; Fu, G. A review of international practices for energy efficiency and carbon emissions reduction and lessons learned for China. *Wiley Interdiscip. Rev. Energy Environ.* **2019**, *8*, e342. [CrossRef]
23. Stoerk, T.; Dudek, D.J.; Yang, J. China's national carbon emissions trading scheme: Lessons from the pilot emission trading schemes, academic literature, and known policy details. *Clim. Policy* **2019**, *19*, 472–486. [CrossRef]
24. Liang, X. *Developing a Linkage-Ready Carbon Market: A View from China. Carbon Market Cooperation in Northeast Asia: Assessing Challenges and Overcoming Barriers*; Asia Society Policy Institute: Washington, DC, USA, 2018.
25. Riehl, B.; Wang, G.; Eshpeter, S.; Zhang, H.; Innes, J.L.; Li, N.; Li, J.; Niles, J.O. Learned in Mandatory Carbon Market Development. *Int. Rev. Environ. Resour. Econ.* **2017**, *10*, 227–268. [CrossRef]
26. Young, D.S.; Casey, E.A. An Examination of the Sufficiency of Small Qualitative Samples. *Soc. Work Res.* **2019**, *43*, 53–58. [CrossRef]
27. Braun, V.; Clarke, V. Using thematic analysis in psychology. *Qual. Res. Psychol.* **2016**, *3*, 77–101. [CrossRef]
28. Braun, V.; Clarke, V. Thematic analysis. In *APA Handbooks in Psychology®. APA Handbook of Research Methods in Psychology, Vol. 2. Research Designs: Quantitative, Qualitative, Neuropsychological, and Biological*; Cooper, H., Camic, P.M., Long, D.L., Panter, A.T., Rindskopf, D., Sher, K.J., Eds.; American Psychological Association: Washington, DC, USA, 2012.
29. Nowell, L.S.; Norris, J.M.; White, D.E.; Moules, N.J. Thematic analysis: Striving to meet the trustworthiness criteria. *Int. J. Qual. Methods* **2017**, *16*, 160940691773384. [CrossRef]
30. Bree, R.T.; Gallagher, G. Using Microsoft Excel to code and thematically analyse qualitative data: A simple, cost-effective approach. *All Irel. J. High. Educ.* **2016**, *8*. Available online: https://ojs.aishe.org/index.php/aishe-j/article/view/281 (accessed on 22 October 2020).
31. Meyer, D.Z.; Avery, L.M. Excel as a qualitative data analysis tool. *Field Methods* **2009**, *21*, 91–112. [CrossRef]

32. Asian Development Bank. *Emissions Trdaing Schemes and Their Linking: Challenges and Opportunities in Asia and the Pacific*; Asian Development Bank: Mandaluyong, Philippines, 2016.
33. Dellatte, J.; Rudolph, S.; Lerch, A. The way of the Dragon: China's new Emissions Trading Scheme and the prospects for Linking. In *Environmental Tax Studies for the Ecological Transition. Comparative Analysis Addressing Urban Concentration and Increasing Transport Challenges*; Villar, M., Ed.; Thomson Reuters: Toronto, ON, Canada, 2019.
34. Townshend, T.; Fankhauser, S.; Aybar, R.; Collins, M.; Landesman, T.; Nachmany, M.; Pavese, C. How national legislation can help to solve climate change. *Nat. Clim. Chang.* **2013**, *3*, 430–432. [CrossRef]
35. China Government. Tentative China National Emission System Regulations. Available online: http://www.gov.cn/zhengce/zhengceku/2021-01/06/content_5577360.htm (accessed on 19 June 2021). (In Chinese)
36. Mehling, M.A. *Legal Frameworks for Linking National Emissions Trading Systems*; Oxford University Press: Oxford, UK, 2016.
37. Zaman, P.; Hedley, A. *Networked Carbon Markets: The Regulatory Framework to Support Carbon Market Linkage–A Concept Paper*; World Bank: Washington, DC, USA, 2016.
38. European Commission. Guidance Document European Commission. 2017. Available online: https://ec.europa.eu/clima/sites/clima/files/ets/monitoring/docs/gd1_guidance_installations_en.pdf (accessed on 22 October 2020).
39. California Air Resources Board. Market Monitoring. 2020. Available online: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/market-monitoring (accessed on 22 October 2020).
40. NDRC. Chinese National ETS Regulations and Design Work Plan. 2017. Available online: http://www.ndrc.gov.cn/gzdt/201712/W020171220577386656660.pdf (accessed on 22 October 2020). (In Chinese)
41. Weng, Q.; Xu, H. A review of China's carbon trading market. *Renew. Sustain. Energy Rev.* **2018**, *91*, 613–619.
42. Dellatte, J.; Rudolph, S. Linking ETS in East Asia: Process, Alignments and future Management. In *Climate and Energy Policies in the EU, Korean and China—Transition, Policy Cooperation and Linking*; Kim, S.W., Ed.; Edward Elgar: Northampton, MA, USA, 2021.
43. Tang, R.; Guo, W.; Oudenes, M.; Li, P.; Wang, J.; Tang, J.; Wang, L.; Wang, H. Key challenges for the establishment of the monitoring, reporting and verification (MRV) system in China's national carbon emissions trading market. *Clim. Policy* **2018**, *18*, 106–121. [CrossRef]
44. Kachi, A.; Unger, C.; Böhm, N.; Stelmakh, K.; Haug, C.; Frerk, M. Linking emissions trading systems: A summary of current research. *Int. Carbon Action Partnersh.* Available online: https://pmrturkiye.csb.gov.tr/wp-content/uploads/2016/06/ICAP_Linking-Input-Paper.pdf (accessed on 22 October 2020).
45. Doda, A.B. Barriers to Linking Carbon Markets in Northeast Asia. In *Carbon Market Cooperation in Northeast Asia: Assessing Challenges and Overcoming Barrier*; Asia Society Policy Institute: New York, NY, USA, 2018.
46. Unger, C. *Linking the European Union Emissions Trading System: Political Drivers and Barriers*, 1st ed.; Routledge: Oxfordshire, UK, 2021.
47. Mo, L.; Lu, X. Barriers and Options for Carbon Market Integration. In *Investing on Low-Carbon Energy Systems*; Anbumozhi, V., Kalirajan, K., Kimura, F., Yao, X., Eds.; Springer: Singapore, 2016.
48. Maeda, A. The emergence of market power in emission rights markets: The role of initial permit distribution. *J. Regul. Econ.* **2003**, *24*, 293–314. [CrossRef]
49. Honjo, K. Cooperative emissions trading game: International permit market dominated by buyers. *PLoS ONE* **2015**, *10*, e0132272. [CrossRef]
50. Sino Carbon. EU Carbon Price Drops 5% to Low in Nearly 7 Weeks-Weekly Report on the World's Six Major Carbon Markets. 2020. Available online: http://www.tanjiaoyi.com/article-32087-1.html (accessed on 22 October 2020). (In Chinese).
51. Gulbrandsen, L.H.; Wettestad, J.; Victor, D.G.; Underdal, A. The political roots of divergence in carbon market design: Implications for linking. *Clim. Policy* **2018**, *19*, 427–438. [CrossRef]
52. Wood, P.J.; Jotzo, F. Price floors for emissions trading. *Energy Policy* **2011**, *39*, 1746–1753. [CrossRef]
53. Kollenberg, S.; Taschini, L. The European Union Emissions Trading System and the Market Stability Reserve: Optimal Dynamic Supply Adjustment. CESifo Working Paper Series No. 5380. 2015. Available online: https://ssrn.com/abstract=2615742 (accessed on 22 October 2020).
54. California Air Resources Board. Allowance Allocation. 2020. Available online: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation (accessed on 22 October 2020).
55. Ministry of Sustainable Development, Environment, and Fight Against Climate Change. Calculation Method Used to Determine the Quantity of Emission Units Allocated Free of Charge. 2020. Available online: http://www.environnement.gouv.qc.ca/changements/carbone/methode-calcul-en.htm (accessed on 22 October 2020).
56. Xiong, L.; Shen, B.; Qi, S.; Price, L.; Ye, B. The allowance mechanism of China's carbon trading pilots: A comparative analysis with schemes in EU and California. *Appl. Energy* **2017**, *185*, 1849–1859. [CrossRef]
57. Kollenberg, S.; Taschini, L. Emissions trading systems with cap adjustments. *J. Environ. Econ. Manag.* **2016**, *80*, 20–36. [CrossRef]
58. California Air Resources Board. Allowance Allocation to Industrial Facilities. 2020. Available online: https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/allowance-allocation/allowance-allocation-industrial (accessed on 22 October 2020).
59. Feng, S.; Howes, S.; Liu, Y.; Zhang, K.; Yang, J. Towards a national ETS in China: Cap-setting and model mechanisms. *Energy Econ.* **2018**, *73*, 43–52. [CrossRef]

60. Pang, T.; Duan, M. Cap setting and allowance allocation in China's emissions trading pilot programmes: Special issues and innovative solutions. *Clim. Policy* **2016**, *16*, 815–835. [CrossRef]
61. Zhang, L.; Li, Y.; Jia, Z. Impact of carbon allowance allocation on power industry in China's carbon trading market: Computable general equilibrium-based analysis. *Appl. Energy* **2018**, *229*, 814–827. [CrossRef]
62. Qi, S.; Cheng, S. China's national emissions trading scheme: Integrating cap, coverage and allocation. *Clim. Policy* **2018**, *18*, 45–59. [CrossRef]
63. Munnings, C.; Morgenstern, R.D.; Wang, Z.; Liu, X. Assessing the design of three carbon trading pilot programs in China. *Energy Policy* **2016**, *96*, 688–699. [CrossRef]
64. Charles, A.; Darné, O.; Fouilloux, J. Market efficiency in the european carbon markets. *Energy Policy* **2015**, *60*, 785–792. [CrossRef]
65. Hua, Y.; Dong, F. China's carbon market development and carbon market connection: A literature review. *Energies* **2019**, *12*, 1663. [CrossRef]
66. Ibikunle, G.; Gregoriou, A.; Hoepner, A.G.; Rhodes, M. Liquidity and market efficiency in the world's largest carbon market. *Br. Account. Rev.* **2016**, *48*, 431–447. [CrossRef]
67. Zhao, X.; Jiang, G.; Nie, D.; Chen, H. How to improve the market efficiency of carbon trading: A perspective of China. *Renew. Sustain. Energy Rev.* **2016**, *59*, 1229–1245.
68. Erdmann, K.; Zaklan, A.; Kemfert, C. Linking cap-and-trade systems and green finance. *Vierteljahrshefte Wirtsch.* **2019**, *88*, 89–100. [CrossRef]
69. Lin, B.; Jia, Z. The impact of emission trading scheme (ETS) and the choice of coverage industry in ETS: A case study in China. *Appl. Energy* **2017**, *205*, 1512–1527. [CrossRef]
70. Ministry of Sustainable Development, Environment, and Fight Against Climate Change. The Carbon Market, a Green Economy Growth Tool. 2020. Available online: http://www.environnement.gouv.qc.ca/changementsclimatiques/marche-carbone_en.asp (accessed on 22 October 2020).
71. Fan, Y.; Wang, X. Which sectors should be included in the context of a unified carbon market in China? *Energy Environ.* **2014**, *25*, 613–634. [CrossRef]
72. Qian, H.; Zhou, Y.; Wu, L. Evaluating various choices of sector coverage in China's national emissions trading system (ETS). *Clim. Policy* **2018**, *18*, 7–26. [CrossRef]
73. Jegou, I.; Rubini, L. The Allocation of Emission Allowances Free of Charge: Legal and Economic Considerations. ICTSD Global Platform on Climate Change, Trade Policies and Sustainable Energy Issue 14. 2011. Available online: https://ssrn.com/abstract=1914997 (accessed on 22 October 2020).
74. Wang, X.; Teng, F.; Wang, G.; Zhou, S.; Cai, B. Carbon leakage scrutiny in ETS and non-ETS industrial sectors in China. *Resour. Conserv. Recycl.* **2018**, *129*, 424–431. [CrossRef]
75. Wang, X.; Teng, F.; Zhou, S.; Cai, B. Identifying the industrial sectors at risk of carbon leakage in China. *Clim. Policy* **2017**, *17*, 443–457. [CrossRef]
76. Lo, A.Y.; Cong, R. After CDM: Domestic carbon offsetting in China. *J. Clean. Prod.* **2017**, *141*, 1391–1399. [CrossRef]
77. Trotignon, R. Combining cap-and-trade with offsets: Lessons from the EU-ETS. *Clim. Policy* **2012**, *12*, 273–287. [CrossRef]
78. Zhang, M.; Liu, Y.; Su, Y. Comparison of carbon emission trading schemes in the European union and China. *Climate* **2017**, *5*, 70. [CrossRef]
79. Li, L.; Ye, F.; Li, Y.; Chang, C. How will the chinese certified emission reduction scheme save cost for the national carbon trading system? *J. Environ. Manag.* **2019**, *244*, 99–109. [CrossRef] [PubMed]