Emissions Trading Systems In Europe, China, Asia Under The Bibliometrics Analysis And Suggestions For Vietnam

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Abstract

Research purpose:
The objective of this study is to provide knowledge on the characteristics of Emissions Trading Systems (ETS) in Europe, China, and Asian countries through bibliometric analysis. We also try to analyze the countries' experiences to make suggestions for Vietnam in implementing the ETS in the future.

Research motivation:
ETS are considered instruments to mitigate the impacts of global climate change. The carbon market innovation marks an essential step in the drive towards a carbon-neutral economy. In Vietnam, aiming for Net zero by 2050, these instruments are essential but have not been applied. Several climate action trackers even accuse Vietnam of taking emissions reduction lightly, from the top authority to the economic organizations.

Research design, approach, and method:
We employed the systematic literature review and the bibliometric analysis methods to identify the situation of ETS research in selected areas, such as Europe, which is the pioneer in carbon reduction policies, China, which is the second biggest country in the world, and Asia, which is the most dynamic area in the world to understand the characteristics of ETS in these areas.

Main findings:
Using the bibliometric analysis, we found the main focus of ETS research in Europe, China, and Asian countries from 2014 to 2024. Also, in combination with the systematic literature review, we found the experiences of the interplay between policy design, market dynamics, and the industrial landscape in shaping the success of ETS in the countries and made suggestions for Vietnam.

Practical/managerial implications:
The potential benefits of implementing ETS in Vietnam are significant. They offer hope for a more sustainable future and enhance Vietnam's international standing in climate negotiations, demonstrating a robust commitment to global climate goals. These systems could significantly reduce greenhouse gas emissions, promote clean energy development, and stimulate economic growth, bringing a sense of positivity and progress to organizations.

Keywords: Emissions Trading Systems, Europe, China, Asia, Vietnam

1. INTRODUCTION

The goal of limiting global warming to 1.5-2 degrees Celcius requires reducing global greenhouse gas (GHG) emissions by 25 to 50 percent. As a result, Emission Trading Systems (ETS) were created to make polluters pay for their emissions, thereby incentivizing reductions. While greenhouse gas reduction policies are attractive, there is still much uncertainty about pricing, which hinders innovation. One way to address this is to set an ETS cap, which caps total greenhouse gas emissions and allows low-emitting industries to sell their additional allowances to more significant emitters. This system would establish a market price by creating supply and demand for allowances. An ETS limits emissions from covered entities by issuing tradable emission units that entities can use to meet their compliance

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obligations.

The EU Emissions Trading System, launched in 2005, is the world's first carbon market and remains the largest globally. It helps reduce overall EU emissions while generating revenues to finance green transition projects in the EU and worldwide. China, being the second-largest economy globally and potentially the first in the future, has seen significant growth in research on ETS implementation due to its influence on the global carbon market. Asia is currently the most dynamic region in the world economy. The ETS and carbon markets are attracting considerable research attention in Asian countries.

Vietnam is in the process of establishing a carbon market and carbon trading system. By 2026, the proposed official carbon market for listed companies is predicted to be launched in Vietnam. ETS is considered an important essential instrument in the carbon market, and ETSs can have significant political economy advantages. ETSs provide more certainty over emissions levels, can be implemented by environment ministries, and some free permit allocations might garner political support from affected firms (at a fiscal cost). Revenue in the EU ETS has increased sevenfold since 2017. This is partly due to higher prices and the gradual shift from free allocation toward auctioning. Research numbers in China and Asian countries on ETS are considerably increasing. Currently, Vietnam lacks research on the carbon market and carbon trading system.

Therefore, the main objective of this study is to focus on the characteristics of ETS in Europe, China, and Asia and the research situations in these areas to deepen understanding and successfully apply the knowledge in Vietnam in the future This study is structured as follows: Section 2 presents the literature review. Section 3 shows the research methods. Section 4 shows the results and discussions. Section 5 presents the conclusions of the study.

2. LITERATURE REVIEW

Carbon Pricing

In theory, carbon pricing can be implemented via a carbon tax (CT), where emitters pay a fee based on their CO2 emissions, or through an emissions trading scheme (ETS), where emitters buy and sell emission allowances granted by the government. A key difference between these approaches is that an ETS might lead to less efficient abatement methods and higher overall costs. Moreover, the scale of the emissions trading market can impact the ETS's effectiveness; a larger market, for example, can lead to greater liquidity and reduced price volatility. While economists and policy analysts generally support the efficiency of broad carbon pricing programs, there is less consensus on which specific carbon pricing mechanisms are best for different countries. Carbon pricing policies' social impact and distributional effects are crucial in determining their acceptability. Therefore, understanding the implications of different carbon pricing strategies is important for developing politically feasible and economically effective policies.

Carbon market

Compliance markets, also referred to as regulated markets or emissions trading schemes (ETS), are established because of national, regional, or international policy or regulatory requirements. In contrast, voluntary markets are subject to less regulation and oversight, allowing businesses and individuals to procure carbon credits or offsets at their discretion (Greg, 2023). Carbon markets are a fundamental component of cap-and-trade programs, wherein governments or coalitions of governments establish a cap on emissions at a predetermined level and assign limits to entities covered by the regulations. Carbon markets aim to assign a value to emissions, thus incentivizing nations and companies to progressively decrease their emissions while financially disincentivizing those who exceed their allotted share. Carbon markets serve as an endeavor to curtail global emissions of greenhouse gases by employing a financial market mechanism, thus playing a pivotal role in achieving cost-effective reductions in global greenhouse gas emissions (Greg, 2023; Liu & Cooper, 2020; KPMG, 2023). Participants are given allowances in these markets based on their emissions targets or caps. The system incentivizes participants to emit less than or equal to their target, thereby theoretically reducing overall emissions in that sector. Compliance markets are considered an economically strategic approach, allowing businesses to decide when and how to invest in new technologies and other advancements to reduce emissions, with the understanding that the costs of emitting will rise as the cap becomes stricter over time.

Emissions Trading System (ETS)

The Emissions Trading System (ETS) is a market-based instrument that governments use to control and gradually reduce greenhouse gas (GHG) emissions in certain sectors or across the entire economy. ETS popularly operates on the principle of "cap and trade". The "cap" is the limit set on the total amount of emissions a business, or multiple sectors of the economy can produce. This cap decreases over time to ensure the effectiveness of emission reductions. The second component of ETS is the allocation of allowances. After setting the emissions cap, the government allocates the corresponding number of allowances to the emitting facilities within the ETS. Each allowance permits the holder to emit one ton of CO2 equivalent (Abbreviated as tCO2e). Allowances can be allocated for free (based on historical emissions or the average emission intensity of a company) or through auctioning. Facilities

regulated by the ETS can trade these allowances with each other to optimize their emission reduction costs. Additionally, these facilities can implement internal emission reduction measures or purchase government-recognized carbon credits to offset emissions. If a facility does not comply with the regulations, it may face penalties of several times the allowance's price.

Facilities within the ETS can trade these allocated allowances among themselves, providing flexibility. This system allows low-emission companies (Facility A) to generate revenue by selling excess allowances. In contrast, high-emission companies (Facility B) can buy additional allowances to stay within their emission limits (*Figure 1*). The ETS is designed to gradually reduce the number of allowances allocated to businesses over time. This causes the price of allowances to rise, prompting facilities to implement their emission reduction measures instead of relying on carbon credits or purchasing excess allowances on the market. This approach aims for a sustainable reduction in emissions within the ETS system. Moreover, the government must decide which sectors of the economy the ETS will cover and which GHGs it will cover. Theoretically, an ETS encompassing a wide range of sectors and GHGs would be most effective. However, in practice, some industries find it difficult to measure and report GHG emissions, while others face significant challenges in reducing emissions due to policy or economic factors.

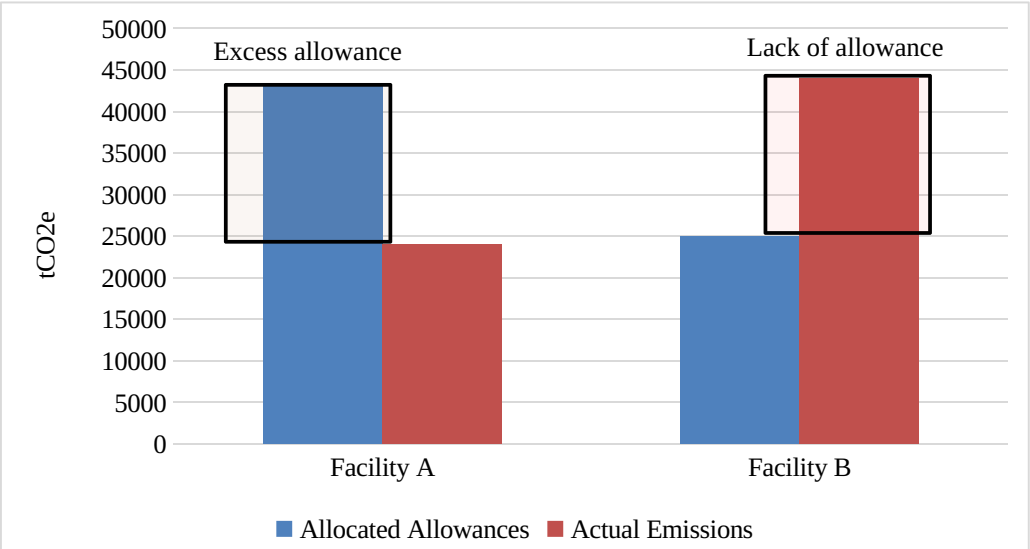

Figure 1. How an ETS works (Source: Authors summarized)

This ETS approach aims to assist industries in achieving their GHG reduction targets while generating revenue for reinvestment in initiatives such as reforestation, green projects, and environmentally sustainable business models. In Vietnam, the Ministry of Natural Resources and Environment (MONRE) is working on a draft decree revising Decree 06/2022 on the mitigation of greenhouse gas (GHG) emissions, development of the carbon market, and protection of the ozone layer, which is expected to improve the legal basis for achieving the goal of net-zero emissions in 2050. The government plans to conduct an emission inventory for specified sectors and facilities (VLLF, 2024). Allowance for emissions during the 2026-2030 period will be allocated, facilitating the operationalization of the carbon market with mitigation targets implemented at both sectoral and facility levels. The national strategy on climate change has set out a roadmap to achieve Net Zero, thereby achieving economic growth. Emissions peak at about 539 million tons of CO2 equivalent in 2035. After that, they will continue to decrease, and by 2050, total greenhouse gas emissions are estimated to reach 185 million tons of CO2 equivalent and will be completely absorbed entirely by natural ecosystems. In the updated Nationally Determined Contribution (NDC) for 2022, Vietnam also commits to voluntarily reduce greenhouse gas emissions by 15.8% compared to the business-as-usual scenario (BAU) and reduced by 43.5% with the support of the international community., building an effective ETS plays a crucial role in achieving the Nationally Determined Contribution (NDC) target.

Table 1. The Methodology Used to Analyse the Impacts of ETS (Source: Authors summarized)

Method	References	Details
Computable general equilibrium (CGE), input-output analysis (IOA), and multi-criteria analysis methods.	Tang & Mizunoya (2024)	It is recommended to employ both (CGE) and (IOA) methodologies to assess the effectiveness and impact of the ETS. IOA is particularly advantageous as it bypasses many of the assumptions that CGE relies on. Applying IOA in future research on Vietnam's Emissions Trading System (ETS) can be an effective tool for analyzing the ETS.

Computable general equilibrium (CGE) & and extension of the GTAP-E model	Nong et al. (2020)	Design two scenarios to consider the impact of ETS on the entire Vietnamese economy. Consider the contribution of different industries participating in the emissions trading market to GDP. Vietnam needs to strongly link its carbon markets with other countries on this issue.
Ex-ante assessment framework: Framework Programmes FP6 and FP7, Integrated assessment	Do & Burke (2021)	Contribute 2 ETS simulation options in Vietnam, focusing heavily on high-emissions simultaneously in time high-emission industries. ETS is an attractive option in the Vietnamese context due to its perceived greater political feasibility. However, if ETS emissions limits are set too loosely, the ETS risks being ineffective. It is possible to have both an ETS and a carbon tax simultaneously.

Carbon Leakage

Climate change, one of the most pressing global issues in recent years, has been partly addressed by the ETS. However, there are still some risks to its implementation, including the potential for “carbon leakage” in cases where climate policy remains voluntary. Carbon leakage occurs when an ETS member company enters a new market with less stringent environmental regulations. Alternatively, where their imports are more carbon-intensive, this is a situation where environmental regulations in one market led to increased emissions in other regions with less ambitious policies (Wang & Kuusi, 2024). Carbon leakage occurs when regulations in one region led to more GHG emissions outside the regulated region than within the region. In addition, carbon leakage is also considered as the difference between the total GHG emissions that occur in the scenario with a specific regulation in place and the total GHG emissions that would occur without the regulation (Park et al.,2024). While carbon leakage can undermine the effectiveness of carbon market policies, shifting production activities can also promote economic development and job creation in the regions that receive these activities. A unified market that eliminates local protectionism and market fragmentation allows carbon leakage to flow into less developed, non-pilot regions, encouraging industrial upgrading and the spread of technological innovations (Zhao, 2024).

ETS related theories

Institutional, stakeholder, and diffusion of innovation (DOI) theories provide unique perspectives on how firms engage with emissions trading systems (ETS). Institutional theory emphasizes how regulatory frameworks and social expectations shape firms' environmental behavior, driving them to innovate and strategically manage emissions (Meyer & Rowan, 1977; DiMaggio & Powell, 1983). Stakeholder theory highlights the influence of diverse stakeholders—such as regulators, environmental groups, and industry participants—on the effectiveness of ETS, fostering corporate transparency and sustainability (Freeman, 2015; Donaldson & Preston, 1995). DOI theory explores the gradual adoption of ETS, where early adopters pave the way for broader engagement as the system's benefits become more precise and regulatory pressures increase (Rogers, 2003; Zhu et al., 2007). Together, these theories illustrate how complex social, economic, and regulatory forces drive the adoption and optimization of ETS.

3. METHODOLOGY

A systematic literature review (SLR) is a process of collecting relevant evidence on a given topic that fits the pre-specified eligibility criteria and the aim of the research (Dewey & Drahota, 2016). The systematic review should follow a clearly defined plan. The research objective is identified before the review is conducted. The literature review must include the search terms, research plan, and limits. In this research, we used the search terms "carbon” and “emissions trading system” or “emissions trading scheme”. We conducted a systematic literature review to identify critical points in the current literature on ETS in previous research in the countries.

Bibliometric analysis is considered standardized to present an overview of various constituents in one place, which gives uniqueness (Donthu et al., 2020). When paired with network analysis by software like VOSviewer, the techniques yield illustrations of the bibliometric and intellectual frameworks (Donthu et al., 2021). VOSviewer is a tool for constructing and visualizing bibliometric networks, including networks of journals, researchers, or individual publications. Bibliometrics has spanned their applicability in agriculture (Yuan & Sun, 2020) and food industry blockchain studies (Niknejad et al., 2021), supply chain management, and carbon taxes (Zhou et al., 2020).

In this study, we employed bibliometric analysis, and the Scopus database was selected due to its reliability, data quality, and resource availability. After using keywords such as ("carbon” and “emissions trading system” or “emissions trading scheme”), a screening process will be conducted to identify the most relevant references. The impacts of the ETS from various sectors will be analyzed and contextualized in the enterprise's situation. The keyword analysis visualization on VOSviewer software illustrates the overall picture of studies on emissions trading systems (ETS)

in China. Keywords such as “carbon emissions trading,” “emission trading scheme,” and “carbon market” are closely related, indicating that these are central topics in the research. These networks can be created based on citation, bibliographic coupling, co-citation, or co-authorship relationships. Additionally, VOSviewer offers text-mining capabilities to build and visualize co-occurrence networks of crucial terms extracted from the scientific literature.
The data is processed through the following steps:

- Step 1. Data collection: Identify a list of documents related to ("carbon” and “emissions trading system” or “emissions trading scheme”), published from 2014 to 2024. The document language is limited to English; the primary document type is articles. This study concerns Econ and Busi in the SCOPUS database.
- Step 2. Information classification: This process manually filters out data from other fields inconsistent with the research problem in the title, abstract, or article content.
- Step 3. Data analysis: Through the collection and classification process, the final data will be analyzed using leading analysis methods, including descriptive statistics and keyword co-occurrence analysis methods. The keyword co-occurrence analysis method uses specialized bibliometric analysis software VOSviewer (Van Eck & Waltman, 2010) to represent the network of keywords, thereby providing an overview of research trends. We have obtained data from 631 articles (EU: 221 articles; China: 288 articles; Asia: 122 articles) in CSV file format, and this data is used to run in VOSviewer software.

4. RESULTS AND DISCUSSION

4.1. Results under the bibliometrics analysis in EU, China, and Asia

Europe (EU)

The VOSviewer bibliometric map provides a detailed view of the European Emissions Trading Scheme (EU ETS) and its intricate connections within the broader environmental policy landscape. The central prominence of the "EU ETS" node, linked closely with terms like "carbon leakage," "climate change," and "carbon price," highlights the EU’s role as a global leader in carbon market design and implementation. The connections to "Kyoto Protocol" and "cap-and-trade" systems underscore the historical and regulatory foundations upon which the EU ETS is built, reflecting its evolution from international climate agreements to a robust regional trading system. The map reveals a strong nexus between "carbon pricing," "environmental policy," and "carbon emissions," indicating that the EU ETS is not just a mechanism for trading emissions but a comprehensive policy tool integrated into the EU's broader environmental strategy. The presence of "aviation" as a connected node points to the inclusion of the aviation sector in the ETS, showcasing the EU's pioneering efforts to expand carbon trading beyond traditional industrial sectors. The results are presented in Figure 2.

The VOSviewer bibliometric map clearly visualizes how the European Union Emissions Trading Scheme (EU ETS) connects with broader environmental policy topics. At its core, the prominent "EU ETS" node, depicted in green, highlights its central role in emissions trading discussions. It is strongly linked to terms like "carbon emissions," "cap-and-trade," and "environmental policy," underscoring the EU ETS's influence on carbon regulation across industries and countries. Several thematic clusters emerge around this node. The red cluster, centered on "emissions trading," connects to terms such as "carbon leakage," "Kyoto Protocol," and "emissions trading system." This reflects how international frameworks, like the Kyoto Protocol, have shaped global carbon markets and points to concerns over "carbon leakage," where businesses may shift to regions with weaker emissions rules. The blue cluster focuses on the economic dimension, featuring terms like "carbon price," "carbon tax," and "carbon pricing." It emphasizes the role of financial mechanisms in driving emissions reduction and highlights how industries such as aviation are impacted. These connections reflect debates on pricing carbon to balance environmental goals with economic realities. Another red cluster links "climate policy" and "climate change" to emissions trading, showing the centrality of the EU ETS in global climate strategies. Additionally, a smaller yellow cluster featuring the "carbon market" reflects the growing interest in how carbon credits are traded globally. Overall, the dense network of connections illustrates the complex, interrelated nature of the EU ETS, carbon pricing, and global environmental policy. It highlights the EU ETS as a key element in the Eur opean climate strategy and the broader effort to reduce global carbon emissions.

Interestingly, the network also highlights potential challenges and areas for future development, such as the issue of "carbon leakage," where industries might relocate to regions with less stringent regulations. This concern, connected to "emissions trading" and "carbon market," suggests ongoing debates about the effectiveness and fairness of the EU ETS. These connections reveal the EU ETS as a dynamic and evolving system deeply embedded in regional and global environmental governance. Future research could focus on how the EU ETS is adapting to new challenges, such as integrating more sectors or addressing carbon leakage, and how its experiences can inform emerging ETS systems in other parts of the world. This analysis indicates the EU's continued role in shaping the global discourse on market-based climate solutions.

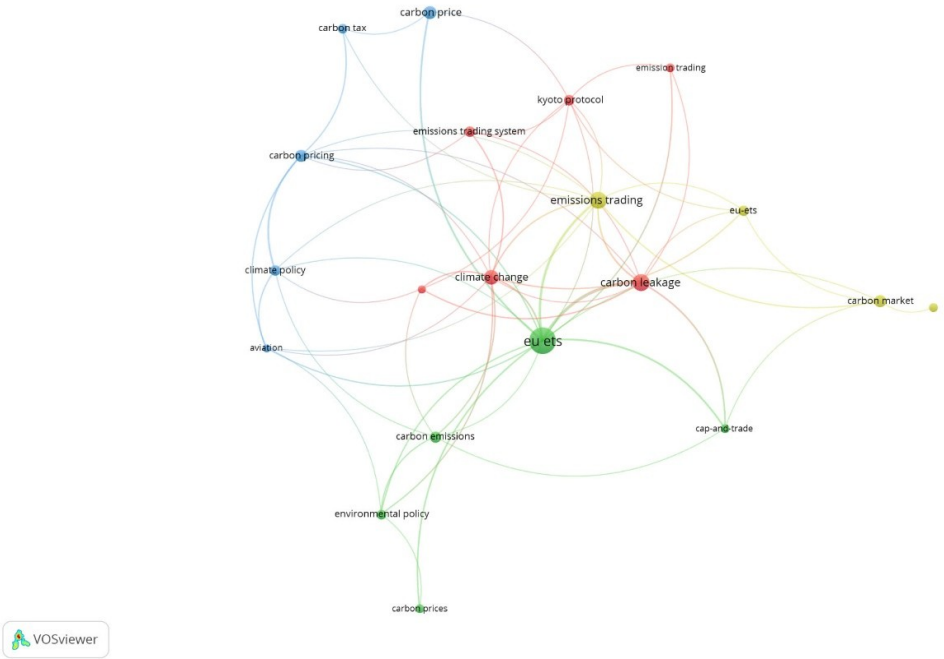

Figure 2. The result of ETS bibliometric analysis in EU (Source: Authors studies)

The EU ETS has played a pivotal role in shaping the EU's environmental and economic landscapes, reflecting a complex interplay between policy effectiveness and market dynamics. Initially designed to mitigate climate change by capping carbon emissions and trading allowances, the EU ETS has had varied impacts on both carbon emissions and economic performance. The EU ETS has demonstrated its potential to significantly reduce carbon emissions, with studies indicating a notable 10% reduction between 2005 and 2012 (Dechezleprêtre et al., 2023). This success is corroborated by evidence of decreased carbon intensity and carbon content in exports from ETS-participating countries (Wang & Kuusi, 2024), suggesting that the system has effectively incentivized cleaner production practices. However, the efficacy of the EU ETS is not without its challenges. The phenomenon of carbon leakage, where emissions reductions in ETS-covered regions are counterbalanced by increased emissions elsewhere, highlights the limitations of the system in isolating its impacts from global trade dynamics (Wang & Kuusi, 2024). Furthermore, the financial implications of ETS participation have introduced an additional layer of complexity, as evidenced by increased audit fees correlated with carbon risk, which underscores the growing financial burden of carbon management (Wei et al., 2023). The efficiency of the carbon futures market also presents areas for improvement, with recommendations suggesting increased market participation and transparency to enhance price discovery and liquidity (Xi et al., 2023). Additionally, the relationship between ETS participation and firm-level pollution reveals an unexpected trend: firms in ETSs often exhibit higher pollution levels, suggesting potential greenwashing or insufficient regulatory impact (Adamolekun et al., 2024). Despite these challenges, the EU ETS has reduced emissions without severely impacting economic performance, particularly in larger firms and sectors with substantial free allowance allocations (Dechezleprêtre et al., 2023). This multifaceted picture underscores the need for ongoing refinement of the ETS framework to address its environmental and economic objectives more effectively.

EU ETS & Carbon Leakage

On July 14, 2021, the European Commission introduced a series of legislative proposals outlining how it plans to achieve climate neutrality in the EU by 2050, including an intermediate goal of at least a 55% net reduction in greenhouse gas emissions by 2030. This package includes revisions to various EU climate regulations, such as the EU Emissions Trading System (ETS), the Effort Sharing Regulation, and legislation related to transport and land use, detailing how the Commission intends to meet climate goals under the European Green Deal (Carbon Leakage, n.d.). However, the efficacy of the EU ETS is not without its challenges. Several studies have analyzed the impact of the EU Emissions Trading System (ETS) on international trade using a gravity model that incorporates CO2 emissions. Findings indicate that while the EU ETS has led to some carbon leakage, it has significantly reduced export value, carbon intensity, and carbon content in participating countries. A comparison with a counterfactual scenario, where the ETS was not implemented, shows that although carbon leakage occurred, the overall trade carbon content increased due to the ETS, balancing the reduction in carbon exports from ETS countries. (Wang & Kuusi, 2024). Under the EU ETS, industries at high risk of carbon leakage are given special provisions to maintain their competitiveness. Carbon leakage occurs when businesses relocate

production to countries with less stringent emission regulations due to the costs of climate policies, potentially leading to an overall rise in emissions. This risk is particularly high in energy-intensive sectors (Carbon Leakage, n.d.).

This study adds to research on the impact of corporate participation in emissions trading schemes (ETS) on pollution. Analyzing global data, it found that companies in ETS tend to emit more CO2, sulfur, and volatile organic compounds (VOCs) than non-participants, with little evidence of pollution reduction over time. Firms that leave ETS continue to pollute at higher levels, while new entrants often increase emissions. The study suggests that some companies may join ETS for greenwashing rather than reducing emissions, potentially hindering sustainable practices and contributing to long-term environmental harm. (Adamolekun et al., 2024b). This may be because some auditors were forced to falsify figures to suppress the company's emissions violations (Keller et al., 2023).

Despite the continued occurrence of carbon leakage, the EU is constantly researching measures to prevent this leakage from the ETS. However, there have not been any very positive results to prevent this (Wang & Kuusi, 2024). The European Union Emissions Trading Market (EU ETS) is the world's largest multinational market. The market is built in 4 consecutive phases: Phase I (2005- 2007, often called the "pilot phase"); Phase II (2008-2012); Phase III (2013-2020); with the fourth phase starting in 2021. The EU ETS achieved immediate emissions reductions at minimal cost. Transparency in the EU ETS is well-established by law, which has created a reliable and liquid market. The Measurement, Reporting, and Verification (MRV) mechanism has increasingly clear and harmonized rules to ensure that emission reductions and allowance allocations are transparent and trustworthy.

Table 2. MRV's mission and importance in supporting ETS operations (Source: Authors summarized)

Mission	Importance
- Develop and define measurement and reporting (M&R) standards for emission sources under the ETS to accurately determine emission levels. - Ensure consistency in M&R requirements across all emission sources - Ensuring they are evaluated according to the same guidelines and due diligence standards. - Enhance the precision and dependability of emissions data for effective ETS operations.	- Foster transparency and clarity. - Build trust and uphold integrity within the (ETS). - Ensure a level playing field and fairness among companies. - Encourage compliance and facilitate enforcement actions against non-compliance. - Maintain data comparability over time and across companies by using consistent methodologies.

The European Union's Carbon Border Adjustment Mechanism (CBAM) aims to impose a fair cost on the carbon emissions associated with producing carbon-intensive goods imported into the EU. This initiative seeks to promote cleaner production practices in countries outside the EU. By ensuring that a carbon price has been paid for the emissions embedded in imported goods, CBAM will create parity between the carbon costs of imports and those produced within the EU, thus supporting the EU's climate goals. It also ensures compliance with World Trade Organization (WTO) rules. The full implementation of CBAM will begin in 2026, following a transitional period from 2023 to 2025. This phased approach coincides with the gradual elimination of free allowances under the EU Emissions Trading System (ETS), helping drive the decarbonization of European industries.

China

China's pivotal role in emissions trading system (ETS) research is highlighted by the keyword analysis in VOSviewer, where terms such as "carbon emissions trading," "emission trading scheme," and "carbon market" are central themes. These keywords indicate the country's robust engagement in developing ETS frameworks as a key component of its climate policy, emphasizing carbon market dynamics and emissions reduction strategies. Furthermore, emerging terms like "carbon neutrality," "carbon price," and "blockchain" suggest forward-looking research directions. The focus on "carbon neutrality" aligns with China's long-term goal of achieving carbon neutrality by 2060, signaling a strong commitment to deep emissions reductions and sustainable development. "Carbon price" highlights a growing interest in the effectiveness of carbon pricing strategies, examining how different models—such as fixed versus market-based pricing—impact the efficiency of emissions reductions. Meanwhile, "blockchain" suggests exploring how advanced technologies can enhance transparency and efficiency in carbon markets, addressing challenges related to tracking, verification, and fraud prevention in trading systems.

In addition to these central and emerging themes, the paragraph identifies several key areas for future research that could inform both China's ETS and global efforts toward sustainable development. One area involves comparing the effectiveness of various emissions reduction mechanisms, which could include an evaluation of China's ETS alongside complementary policies like carbon taxes, renewable energy incentives, or sector-specific regulations. Such comparisons could offer insights into which policies best support China's broader economic and environmental goals. Another important research direction concerns the spatial spillover effects of ETS policies, with studies focusing on how

emissions reductions in one region may affect surrounding areas. This could lead to more comprehensive strategies that account for regional economic integration and cross-provincial environmental impacts. Overall, the current research landscape, as mapped in Figure 3, strongly emphasizes China's evolving carbon market and its critical role in shaping global climate policy, providing valuable lessons for other nations pursuing carbon trading as part of their emissions reduction strategies.

Based on the co-occurrence network in Figure 3, we observed 277/2013 keywords, each appearing in at least three academic articles. It features five prominent clusters, each represented by a different color, showing how different keywords are interconnected within the field. The red cluster at the center is the largest, primarily focusing on core concepts such as “carbon emissions trading scheme” and “carbon market,” reflecting the central role of these terms in the literature. This cluster also includes keywords like “carbon neutrality” and “carbon price,” indicating research directions exploring long-term sustainability goals and pricing mechanisms within carbon markets. The blue and green clusters represent research on specific carbon market mechanisms, with keywords like “blockchain” in the green cluster highlighting the role of emerging technologies in improving transparency and efficiency in carbon markets. The yellow and purple clusters cover broader themes related to emissions trading systems, such as “carbon tax” and “climate change,” which address global and policy-level implications of ETS. This network provides an insightful map of how various research topics interrelate, with a strong focus on carbon trading schemes, policy design, and the integration of technology in achieving emissions reduction goals.

Central to these opportunities is exploring China's impact on global carbon markets, comparing its policies to other nations, and understanding its influence on international climate strategies. Further studies could delve into the role of ETS in achieving carbon neutrality, examining diverse pricing mechanisms, and identifying best practices for net-zero targets. Technological innovations like blockchain offer new frontiers to enhance market transparency and efficiency, while comparative studies of carbon taxes and renewable credits could clarify the most effective pathways for emissions reduction. Additionally, examining the socio-economic benefits of ETS, such as green job creation, and the effects of regional policy spillovers can provide valuable insights into crafting equitable and robust carbon trading systems. Together, these research directions aim to foster a more sustainable and globally integrated approach to emissions reduction, aligning with both climate and socio-economic goals.

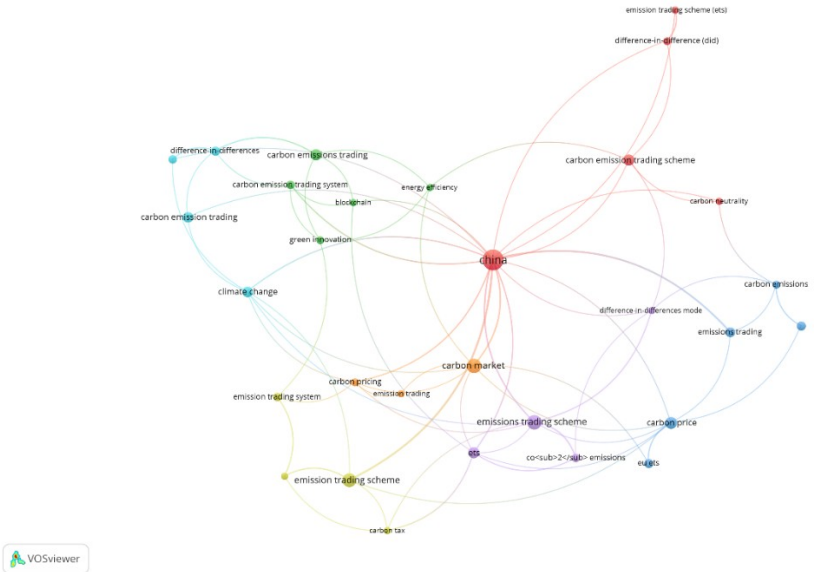

Figure 3. The result of ETS bibliometric analysis in China (Source: Authors studies)

The formation and piloting of ETS in China have been shaped by a complex interplay of economic, environmental, and policy factors, reflecting the nation's strategic approach to sustainable development and its global positioning. The pilot programs in cities like Beijing have demonstrated considerable progress in market liquidity and compliance, albeit with ongoing challenges in regulatory frameworks that need refinement to ensure long-term success (Hu et al., 2017). Economic policy uncertainty (EPU) has also emerged as a critical determinant of ETS market volatility, with domestic and global uncertainties contributing to fluctuations in market prices (Liu et al., 2023). This underscores the interconnectedness of policy environments and suggests that stabilizing policy frameworks could help mitigate these fluctuations, fostering a more predictable trading environment. Moreover, China's ETS initiatives are not merely environmental instruments but also tools for regional economic integration and geopolitical strategy. The symbolic and strategic use of carbon trading reflects China's ambition to assert global leadership in climate governance while advancing its sustainable development goals (Lo, 2015). The introduction of innovative mechanisms, such as a blockchain-based auction design, further illustrates China's commitment to enhancing transparency, security, and

efficiency in the carbon trading process, addressing concerns about data accuracy, compliance, and market credibility (Chen et al., 2023; Li et al., 2022).

These schemes have also shown positive socio-economic impacts, such as fostering employment growth through green job creation and generating spatial spillover effects that benefit neighboring regions (Yu & Li, 2021). Revenue-neutral approaches, like redirecting carbon market revenues to sectors within the ETS via VAT relief, have effectively minimized GDP impacts while promoting equitable growth and energy transition (Qi et al., 2024). Additionally, empirical evidence suggests that participation in ETS has incentivized firms to reduce emissions and adopt cleaner technologies, thereby promoting a sustainable energy transition (Adamolekun et al., 2024; Ren et al., 2024). Collectively, these findings indicate that China's ETS is evolving into a comprehensive policy tool that integrates environmental objectives with economic and social benefits. The success of these schemes hinges on aligning the incentives and strategies of key stakeholders-government, enterprises, and the public to foster collaborative efforts towards sustainable outcomes (Zhang et al., 2023). Tailored policy adjustments, robust regulatory frameworks, and innovative market mechanisms are essential for ensuring the ETS's effectiveness in achieving China's broader goals of economic resilience, environmental sustainability, and global leadership in climate action.

Asia

The VOSviewer visualization offers a compelling glimpse into the evolving landscape of Emissions Trading Schemes (ETS) in Asia, revealing a network of interrelated concepts that underscore the region's engagement with carbon markets. Examining the nodes in the VOSviewer network, the connections paint a vivid picture of the intricate relationships shaping the Emissions Trading Schemes (ETS) landscape in Asia. The dominant nodes, such as "carbon pricing" and "climate change," serve as hubs, linking to diverse concepts like "carbon tax," "emission trading," and "renewable energy." These connections suggest that ETS in Asia is not just a market mechanism but a complex interplay of economic, environmental, and policy factors. The results are presented in Figure 4.

Based on the co-occurrence network in Figure 4, we observe 27/460 keywords, each appearing in at least three academic articles. The nodes in the figure represent individual keywords, where the size of each node reflects the frequency of its appearance. The keywords are grouped into five main clusters. The three clusters-purple, green, and red-focus primarily on carbon markets, emissions trading schemes, and renewable energy, respectively. The purple cluster shows a concentration around emissions trading schemes and their relationship to energy efficiency, signifying research on policy mechanisms to manage carbon emissions. The green cluster highlights research in emissions trading systems with specific reference to national policies such as those in Korea and Japan, linking these policies to carbon pricing strategies. The red cluster is primarily associated with carbon risks and the broader carbon market, including its relationship with renewable energy. The remaining clusters-yellow and blue-focus on broader issues, such as climate policy, carbon leakage, and global carbon pricing frameworks, addressing the economic and environmental implications of these mechanisms.

The proximity of "Korea" and "Japan" to key terms like "carbon price" and "emissions trading scheme" hints at these countries' leadership in navigating the challenges of carbon regulation. Interestingly, the presence of "carbon leakage" and "carbon risk" nodes suggests ongoing concerns about the potential downsides of ETS, such as the displacement of emissions and financial uncertainties. The network's structure also reveals a possible emerging trend: the growing importance of integrating renewable energy into ETS frameworks, as indicated by the connections to "renewable energy" and "energy efficiency." This suggests that Asia's ETS is evolving beyond traditional carbon markets to include broader sustainability goals. In this web of connections, one can deduce that Asia's approach to ETS is both ambitious and cautious, balancing the urgency of climate action with the complexities of economic growth and market stability. Future research could explore how these intertwined factors influence the success of ETS in different Asian countries, potentially uncovering innovative strategies for harmonizing carbon markets with renewable energy integration.

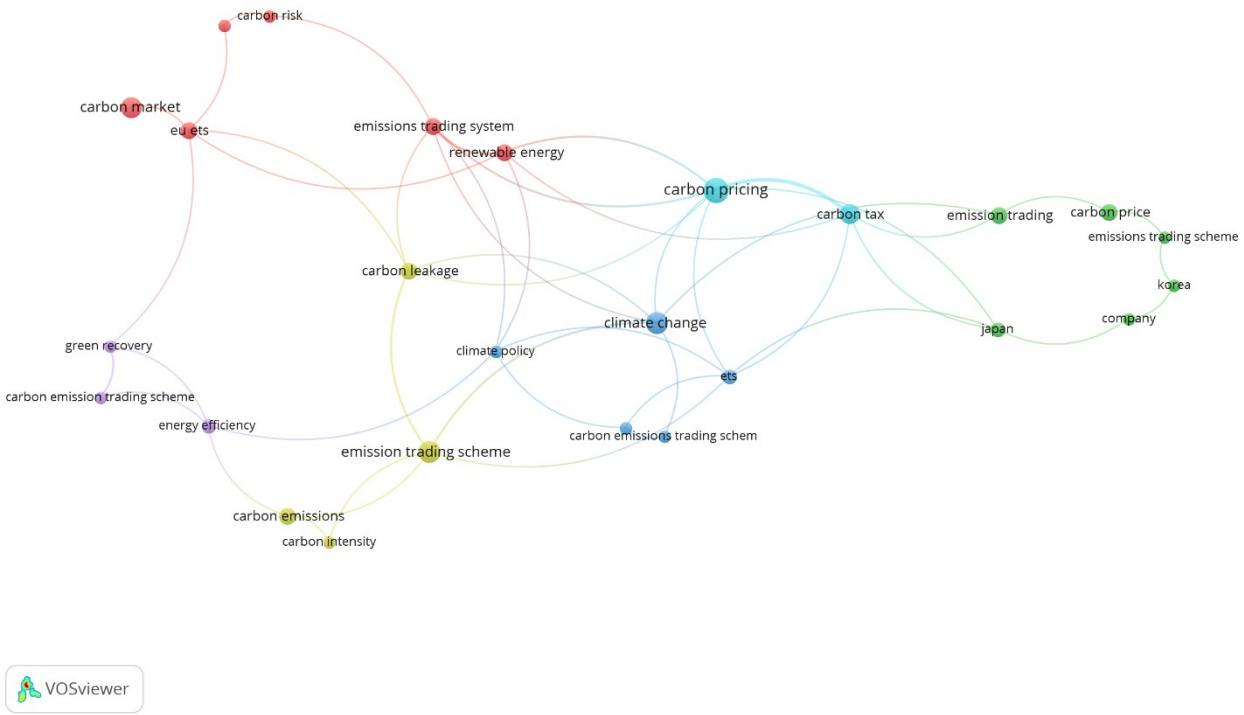

Figure 4. The result of ETS bibliometric analysis in Asia (Source: Authors studies)

The formation and implementation of Emissions Trading Schemes (ETS) in Asia have demonstrated a diverse array of challenges and opportunities reflective of the region's varied economic, political, and industrial landscapes. While several Asian countries have adopted ETS as a market-based tool to reduce greenhouse gas (GHG) emissions, the effectiveness and design of these systems have varied significantly, shaped by both local and international pressures.

In South Korea, the ETS has been marked by a balancing act between regulatory imperatives and market efficiency. Established in 2015, the Korean ETS aimed to cap and reduce GHG emissions across major industries. However, it has faced criticism for its overly lenient targets and the prioritization of policy objectives over market responsiveness. This has led to a situation where the ETS has yet to fully achieve its potential in driving industrial efficiency and innovation in sustainable practices (Tan et al., 2024). The Korean government has acknowledged these shortcomings and is now focusing on enhancing the policy's effectiveness by adopting a more stringent and customized approach to target distribution, particularly in the face of new challenges posed by international measures like the Carbon Border Adjustment Mechanism (CBAM) (Cho et al., 2024). Similarly, in Japan, the regional ETSs in Tokyo and Saitama have provided insightful lessons on the dynamics of carbon leakage and the role of stringent regulations in fostering energy efficiency. Japanese ETSs, although regional in scope, have been instrumental in reducing emissions at regulated facilities, even as concerns about carbon leakage within firms linger. The Tokyo ETS, which is noted for its stringent regulations, has successfully driven down emissions in regulated and unregulated facilities, demonstrating a positive spillover effect that offsets potential negative impacts. This outcome underscores the importance of regulatory rigor in ETS design, as more stringent frameworks appear to compel firms to adopt more comprehensive and effective emissions reduction strategies (Taisuke & Toshi, 2021).

The experience of these countries highlights the complex interplay between policy design, market dynamics, and the industrial landscape in shaping the success of ETS in Asia. The region's ETS initiatives reveal that while market-based mechanisms hold significant potential for driving sustainability, their effectiveness is contingent on tailored approaches that account for local conditions and the specific needs of industries. Moreover, the growing interconnectedness of Asian economies and their increasing integration into global trade systems underscores the importance of aligning ETS frameworks with international standards and practices, as seen in the efforts to harmonize Korea's ETS with the broader requirements of the CBAM. These developments also reflect the broader regional challenge of balancing economic growth with environmental sustainability. As Asian economies continue to industrialize and urbanize, the pressure to reduce emissions while maintaining competitive industrial sectors is mounting. ETS, in this context, emerges not just as a regulatory tool, but as a catalyst for innovation, pushing firms toward greener technologies and more efficient production processes. The varied experiences of South Korea and Japan with ETS underscore the need for adaptive and flexible policy frameworks that can respond to the unique economic and

environmental challenges faced by Asian countries. By learning from these experiences, other nations in the region can design more effective ETS policies that contribute to both national sustainability goals and the global fight against climate change.

4.2 Comparing ETS in China and EU

Carbon pricing in the EU:

Furthermore, allowance prices have fluctuated significantly over the years. According to European Energy Exchange data, the spot price was around 80 Euros per tonne of CO2 in January 2022, compared to about 3 Euros in 2013. For most of the study period, allowance prices were relatively low, so their impact was minimal in the early phases. Concerns about the over-allocation of free permits and price volatility were prominent during the first three phases of the EU ETS. However, prices have been rising recently. According to the European Commission, total emissions in the EU have decreased to 21% below 2005 levels, meeting the 2020 target. Recent research confirms that emissions have indeed fallen for firms under the ETS (Wang & Kuusi, 2024). The secondary carbon price effect on non-EU markets is expected to be weaker than the primary effect on the EU, potentially resulting in a small impact on EU imports. However, similar effects are likely even if higher-tier intermediate production is considered. Overall, EU carbon prices have remained volatile (Wang & Kuusi, 2024).

The Symbolism of Chinese Climate Capitalism:

China's regime and society aim to alter the unequal power dynamics in international carbon markets. China seeks to gain economic control from global actors by creating domestic demand and carbon institutions. Developing a carbon trading system aligns with its goal of increasing global market power. This push for a national carbon market is driven by past experiences where China's interests were seen as compromised by developed nations. The economic principles and emissions trading requirements are not fully compatible with China's context. Several factors, including political resistance, structural challenges, the need to sustain economic growth, and significant institutional shortcomings, provide solid reasons for China to resist adopting a "cap and trade" system (Lo, 2015). First, China's development priorities clash with the requirement of a binding emissions cap, which is essential for a standard ETS (Zhang 2007, 2011). The government has invested significant political effort in opposing a nationwide emissions cap. A mandatory cap is crucial for a "cap and trade" system that regulates total emissions. Committing to a national ETS could open the door to international demands and expectations that China continues to resist. Even within the country, pilot ETS programs have faced opposition (Liu et al., 2012). Local governments are hesitant to impose emission caps, viewing them as potential barriers to economic growth. (Gilley, 2012). Second, the domestic regulatory and market conditions are not conducive to large-scale carbon trading (Adams, 2013; Han et al., 2012). The fragmented markets have more supply than demand, and the systems for monitoring and managing greenhouse gas emissions are incomplete (Shen 2015). Price controls and government intervention are still prevalent. These limitations and the tradition of price controls might make carbon taxes a more practical option, as they involve lower transaction costs (Lo, 2013). In contrast, carbon trading is administratively expensive due to China's regulatory framework, which is not designed for market mechanisms (Gang et al., 2011). With weak domestic demand, carbon trading is unlikely to offer significant short-term benefits. China needs more time to develop an effective carbon trading system than the central government's short two-to-three-year timeframe from 2013 allows (Lo, 2015). In China, business consultations are also limited (Engels et al., 2015). Carbon taxes might have suited the domestic context better, as early domestic carbon trading efforts were uncoordinated and primarily focused on short-term gains and enhancing public image without significant environmental benefits. However, carbon trading has proven to be more politically appealing. High-level coordination is now in progress, and centrally approved pilot ETS programs have been implemented. (Lo, 2015)

China's carbon leakage prevention campaign:

China has introduced several low-carbon policies, including the Emissions Trading Scheme (ETS) and low-carbon city pilots to fulfill its carbon reduction commitments. ETS, a flexible, market-based approach, was first approved in 2011 for seven regions: Beijing, Tianjin, Shanghai, Chongqing, Shenzhen, Guangdong, and Hubei, with Fujian and Sichuan joining in 2016. These initiatives laid the foundation for a national carbon trading market, vital for China's CO_2 peak and carbon neutrality goals. Although ETS has shown promise in reducing emissions (Zhang et al., 2019; Hong et al., 2022), concerns remain that such unilateral policies may lead to carbon leakage as industries shift outside regulated areas. Unilateral policies can push economic activities outside regulated areas, leading to carbon leakage and lower carbon prices. Evidence shows that firm relocation reduces carbon prices, as excessive allowances in China's ETS pilots create an oversupply in carbon markets. The scale of allowance transactions largely depends on demand, and shifting demand to supply can decrease transaction volumes. Overall, China's ETS pilot programs have inadvertently accelerated company relocations, significantly dropping carbon credit prices and undermining China's position in the international carbon market (Pan & Yu, 2024).

4.3. Suggestions for Emissions Trading System (ETS) in Vietnam

According to Decree No. 06/2022/ND-CP, Vietnam is set to launch a national carbon market trial by 2026, with complete implementation expected by 2028. This initiative and the Environmental Law of 2020 establish a regulatory framework for reporting annual greenhouse gas (GHG) emissions. The Ministry of Natural Resources and Environment, in collaboration with the Ministry of Finance, is developing emission quotas for various sectors and businesses. Participants, including companies, organizations, communities, and individuals, can trade unused allowance or surplus carbon credits within the domestic market, particularly those from green industries. Monitoring, Reporting, and Verification (MRV) of emissions play a vital role in the credibility of any emission trading system, ensuring that a tonne emitted is a tonne reported'. Vietnam needs to have a framework requiring the preparation of a Monitoring Plan (MP) and approval by the competent authority. In alignment with the Paris Agreement Implementation Plan, Vietnam has set forth initiatives to establish a domestic carbon market and conduct pilot projects in promising sectors. Nevertheless, current financial policies related to the trading and utilization of various carbon credits remain insufficient, particularly concerning voluntary market credits and market instruments for carbon credits. This gap is evident in the green growth and GHG emission reduction efforts within potential sectors, necessitating careful consideration and selection of appropriate measures for implementation.

Historically, Vietnam has initiated several CDM projects and developed a financial policy framework under Decision No. 130/2007/QD-TTg to facilitate carbon credit exchanges. Four projects have been registered under the Joint Crediting Mechanism (JCM), and several greenhouse gas mitigation projects are recognized under standards such as the Verified Carbon Standard (VCS) and the Gold Standard (GS). However, a comprehensive financial policy remains lacking to directly support the formation of a unified carbon credit exchange market in Vietnam. Furthermore, under the Paris Agreement, carbon credits from CDM projects are set to transition to the Sustainable Development Mechanism (SDM) by the end of 2020. Establishing an emission trading mechanism presents significant complexity, requiring extensive preparation to develop the necessary carbon pricing infrastructure and capacity.

As analysed above, many Emission Trading Systems (ETS) permit emitters to utilize carbon credits, offering a flexible mechanism to diversify emission reduction strategies. This approach becomes advantageous when the costs of internal emission reductions or trading emissions quotas are prohibitive. One of the primary benefits of integrating a carbon credit scheme into an ETS is its capacity to maximize emissions reductions from sectors that are challenging to include directly within the ETS framework. Sectors like forestry and agriculture often face technical or operational barriers that preclude their full participation in ETS (excluding the New Zealand ETS, which includes forestry). However, most global ETS systems accept carbon credits generated from activities such as afforestation, forest protection, preventing forest degradation, and emissions reductions in agriculture. This fosters initiatives to reduce emissions in sectors not covered by the ETS, thereby incentivizing investments into areas where financial capital is typically scarce. Recently, Vietnam received a payment of $51.5 million for Carbon credits to reduce deforestation and forest degradation (widely known as REDD+). This payment was transferred to Vietnam due to the reduction of 10.3 million tons of Carbon emissions from February 1, 2018, to December 31, 2019. This is the largest single payment ever from the FCPF Fund for high-quality, verified emissions reductions. This money will benefit 70,555 forest owners and 1,356 communities living near forests, divided according to a broad benefit-sharing plan developed through a transparent consultation process with many stakeholders (World Bank, 2024).

In Vietnam, in addition to clean development mechanism (CDM) projects under Decision No. 130/2007/QD-TTg, various carbon credit types have been established, including Joint Crediting Mechanism (JCM), Verified Emission Reductions (VERs), and Reducing Emissions from Deforestation and Forest Degradation (REDD+). The JCM agreement with Japan does not involve market trading, while the other credits facilitate market trading activities. However, the absence of a specific mechanism or financial policy for this activity has led to implementation challenges.

Given the current situation in Vietnam, implementing a carbon tax, fee, or emission quota trading system requires a long-term strategy. In the short term, prioritizing carbon offsetting mechanisms is more advantageous and effective. By generating carbon credits, the government can continue to regulate market trading activities using the existing legal framework's supportive tax policies and incentives. Notably, Decree No. 06/2022/ND-CP, dated January 7, 2022, addresses mitigating greenhouse gas emissions and protecting the ozone layer, aiming to establish a comprehensive financial legal framework for managing carbon credits and trading on voluntary carbon markets. This decree encompasses regulations for projects that generate carbon credits and those implemented under carbon offsetting mechanisms.

5. CONCLUSIONS AND RECOMMENDATIONS

This study sheds light about ETS research in Europe, China, and Asia to help understand the future of ETS and make recommendations for emerging countries like Vietnam. Benefits of the ETS include cost-efficiency, environmental effectiveness, flexibility, transparency, and innovation promotion. The carbon trading market, a system based on the market, is gaining traction as a better option than conventional climate change strategies. It combines the effectiveness of economic gains with environmental protection measures, which makes it a preferred option for many nations worldwide. Industries are given emission quotas for greenhouse gases under an ETS.

Entities exceeding their emission limits must offset their excess emissions by purchasing offsets in a regulated carbon market. Conversely, Organizations with emissions below their quota can sell surplus emissions to those exceeding their limits. This mechanism establishes a market price for carbon offsets through supply and demand dynamics, often resulting in volatile prices. The volatility of emission prices can influence the effectiveness of greenhouse gas reductions and may reduce incentives for manufacturers to adopt low-carbon technologies by internalizing the costs of emissions. Additionally, for domestic enterprises, carbon pricing can impact their international competitiveness. Developing and implementing an ETS is a complex and lengthy process. Therefore, initially, piloting the ETS in large emission industries with measurable and monitorable emissions, such as thermal power and steel, is advisable.

Addressing policy uncertainty is crucial to ensure the success of Vietnam's ETS. Establishing a stable and predictable policy environment, similar to the approach taken in China, will help mitigate market volatility. Clear and consistent regulations are needed to reduce domestic and global policy uncertainties that could impact the Vietnamese ETS. Regional collaboration and spillover effects can be fostered by encouraging cooperation and policy coordination among regions, leveraging the positive outcomes seen in China's employment impacts. Facilitating knowledge sharing and best practices across different Vietnamese regions will maximize the benefits of the ETS. Strengthening regulatory frameworks and compliance is essential for the integrity of the ETS. Tailoring policies to local contexts is vital, as well as recognizing the diversity of regions and cities in Vietnam. A one-size-fits-all approach should be avoided; instead, targeted policies should be developed based on in-depth analyses of different regions' unique economic and structural factors. Exploring innovative auction designs, such as incorporating blockchain technology, can enhance transparency, security, and efficiency in the carbon allowance auction process. This technological advancement could build trust and credibility in the Vietnamese ETS. Revenue recycling and income distribution strategies, such as revenue-neutral carbon trading, should be explored to reduce emissions with minimal GDP impact. Redirecting carbon market revenues to sectors under the ETS through VAT relief or targeted subsidies can address income disparities and promote sustainable growth. Collaborative strategies and stakeholder alignment are key to the ETS's success. A tripartite approach that aligns the incentives and strategies of the government, enterprises, and the public should be adopted to promote sustainable environmental outcomes. Considering the geopolitical and ideological dimensions of the ETS is essential, as it may have broader implications beyond environmental policy. The Vietnamese ETS can be leveraged to assert the country's leadership in climate action and sustainable development. Incentivizing firm participation is critical, as the ETS should effectively motivate firms to reduce pollution levels and adopt environmentally friendly practices, as observed in China. Continuous regulatory refinement and operational maturity are also necessary. Vietnam can learn an approach by starting with pilot projects focusing on specific sectors like power generation and investing in trading infrastructure and capacity building.

Vietnam can draw on the EU's Emissions Trading System (ETS) experiences by prioritizing R&D in carbon-reducing technologies in the capacity of Vietnam's financial resources and support from green international projects. Innovations like renewable energy, carbon capture and storage (CCS), and energy-efficient systems will help tackle climate change and boost sustainable growth. Besides that, to prevent firms from exploiting the ETS for reputation-building, the government should implement a robust monitoring system, pilot it in high-emission industries, and support it with regulations such as annual emission reduction targets to curb emission increases. Some studies reveal that firms participating in Emission Trading Schemes (ETSs) often face more environmental scandals than non-participants. This suggests that some companies might join ETSs primarily for greenwashing—giving a false impression of environmental responsibility—rather than with a genuine commitment to improving their sustainability. The study also finds that ETS membership might obstruct the shift towards more sustainable operations, leading to long-term negative impacts on corporate carbon emissions. Firms that exit the scheme continue to have higher emissions than their peers, and new entrants often see increased emissions after joining. This indicates that some firms may join ETSs to accommodate future emission increases rather than reduce their carbon footprint. So, coming up with a system to moderate ETS member companies is necessary to maintain a sustainable economy in the future. Given the growing societal focus on climate change and the increasing importance of managing carbon risk, these findings are timely and relevant to a broad

audience. Making ETS auditing a profession will help to reduce emissions further and develop a sustainable economy for society.

Asian countries' experiences highlight the need for Vietnam to adopt a unified national ETS to prevent carbon leakage and ensure consistent policy application across regions. By integrating the Carbon Border Adjustment Mechanism (CBAM) and establishing mutual recognition agreements, Vietnam can align with international standards, reduce trade barriers, and protect industries from carbon tariffs while advancing toward sustainable economic growth. Over the years, carbon pricing has emerged as an auspicious market-based policy instrument, implemented either through an emissions trading system (ETS) or a carbon tax. Therefore, examining and identifying financial regulatory mechanisms for the carbon market, focusing on carbon pricing, is crucial for developing a domestic carbon credit trading market. Mobilizing investment from the private sector is essential to actively engage in GHG emission reduction activities and foster the growth of the domestic carbon market. While carbon credits can support emission reduction efforts, their excessive issuance risks undermine ETS's core objectives by encouraging reliance on credit purchases over internal improvements. Lessons from the European ETS highlight the need for stringent regulations to ensure carbon credits complement, rather than replace, direct sustainability measures.

ETS effectively meets emissions targets and gains political support through free allowance allocations, especially in regions like Europe and Asia. However, ETS has faced price volatility, and revenues are often earmarked, limiting flexibility. Some countries with capacity constraints may find ETS impractical, and legal issues around border adjustments, such as export rebates, are more complex than with carbon taxes. While expanding ETS to cover more emissions sectors could increase total emissions, linking ETS globally might enhance cost-effectiveness. However, a formal international carbon price floor could more effectively support Paris Agreement goals (Green, 2017). Our study contains several limitations due to the lack of detailed data on the ETS measures in the countries and in Vietnam. Also, due to time and technology limitations, we could not expand the studies to more countries. In the future, we would like to dig into this research gap and provide more information on the development of ETS and carbon pricing in general.

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