2022年度第2回【部門C】研究会
9月26日(月)18:30-20:00

Carbon market linkage of China, Japan and Korea and its decarbonization impact on economy and environment: E3ME application case study

SUNHEE SUK (Graduate School of Fisheries and Environmental Sciences, Nagasaki University)
UNNADA CHEWPREECHA (Cambridge Econometrics, currently World Bank)
YIMING LIU (Graduate School of Fisheries and Environmental Sciences, Nagasaki University)
ZIAN CHEN (Graduate School of Fisheries and Environmental Sciences, Nagasaki University)
BENCE KISS-DORBRONYI (Cambridge Econometrics, Corvinus University of Budapest)

Project introduction

Background

- With the growing adoption and enforcement of carbon pricing, **cross-border approaches to carbon markets** are getting more and more attention.
- However, while many existing studies focus on **individual carbon markets**, in particular emerging carbon markets including China, Japan and Korea, few academic studies have covered **carbon market cooperation or feasibility** in this region from a scientific evidence-based standpoint.

Objectives

- This study aims (1) to review the policy status and progress of carbon pricing and market in China, Japan and Korea, and (2) to design a linkaged carbon market for the three counties. More importantly, it targets (3) to study how the harmonized carbon market would impact to the economy and environment of the East Asia region and individual countries under each country's net zero carbon policy scenarios.

Study period

- October to March of 2021FY

Research members

- Kyoto University
- Nagasaki University
- Cambridge Econometrics

Output

- Discussion paper
- Journal paper
- International and domestic conference

Main contents of the Discussion paper

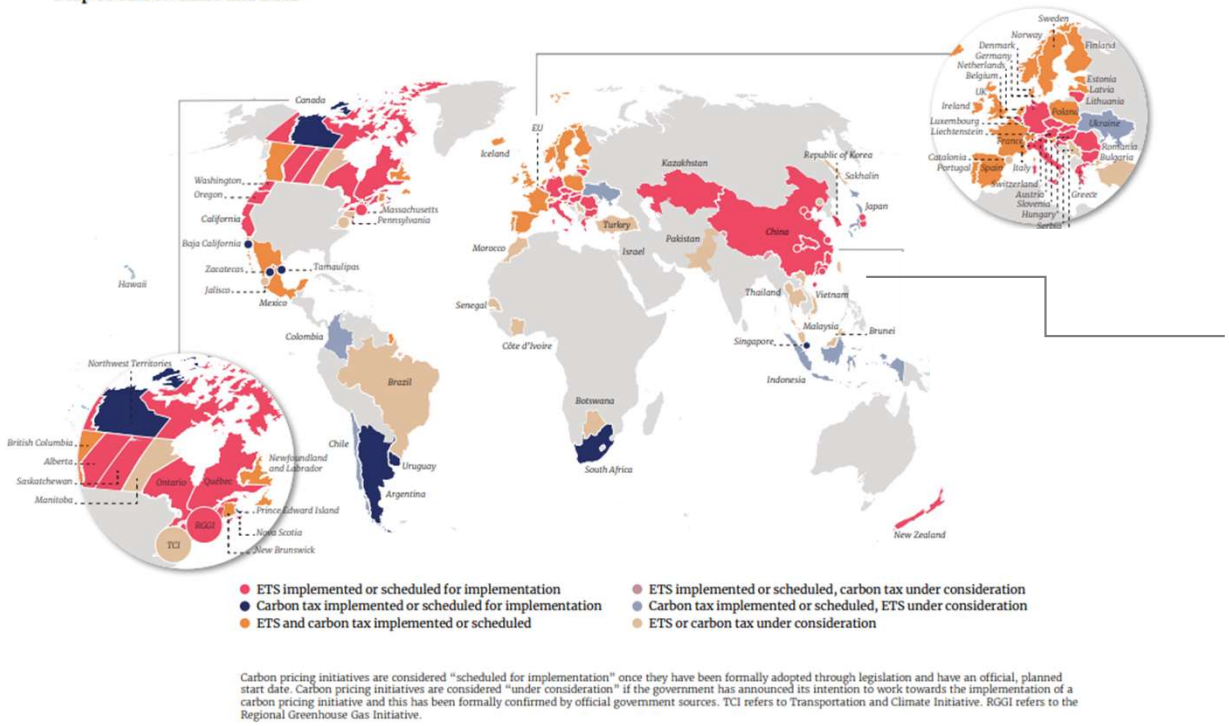
1. Carbon neutrality and carbon market in China, Japan and Korea
2. Carbon market linkage: literature review and Article 6 of Paris Agreement
3. E3ME model analysis
4. Further study

Carbon pricing policy in target countries

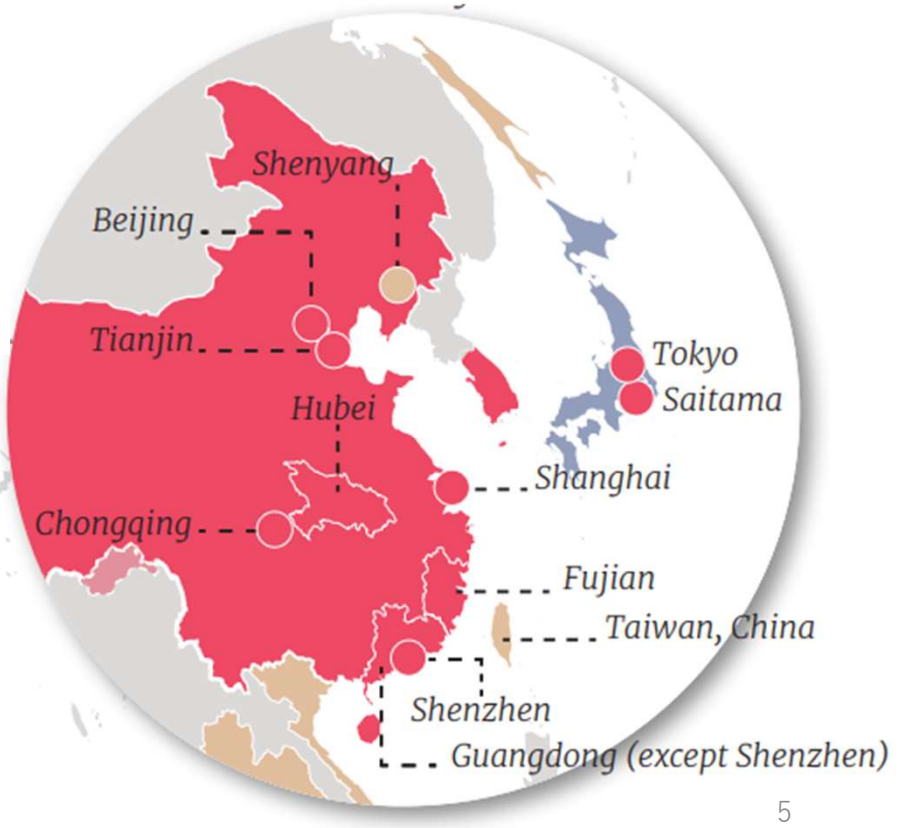
Introduction

- International carbon markets can play a key role in reducing greenhouse gas emissions.
- As of April 2022, 34 ETSs are operating in the world (World Bank, 2021). While national emission trading schemes are implemented and prepared to be in operation in some countries, linking these carbon markets could further help in reducing the cost of cutting emissions (Anger, 2008, M. A. Mehling et al., 2018, Doda et al., 2019, Oliveira et al., 2019).
- In the Northeast Asian region, China, Japan, and the republic of Korea (hereafter, Korea), which together account for about one third of global GHG emissions, each uses carbon markets to reduce their emissions.

FIGURE 1
Map of carbon taxes and ETSs

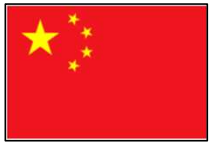
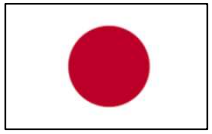


Carbon pricing initiatives are considered "scheduled for implementation" once they have been formally adopted through legislation and have an official, planned start date. Carbon pricing initiatives are considered "under consideration" if the government has announced its intention to work towards the implementation of a carbon pricing initiative and this has been formally confirmed by official government sources. TCI refers to Transportation and Climate Initiative. RGGI refers to the Regional Greenhouse Gas Initiative.



"World Bank. 2022. State and Trends of Carbon Pricing 2022. State and Trends of Carbon Pricing;. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/37455 License: CC BY 3.0 IGO."

Introduction

	GHG mitigation target	Carbon pricing and market
	Peak CO_2 emissions by 2030 Carbon neutrality by 2060	2013: Pilot carbon markets in 7 regions (Beijing, Chongqing, Guangdong, Hubei, Shanghai, Shenzhen and Tianjin) 2021: A national system– the world's single largest carbon market in terms of covered emissions amount.
	46% compared to 2013 by 2030 Carbon neutral by 2050	2008: Domestic voluntary carbon offset market (J-VER) 2010-2011: Linked trading schemes at a city level in Tokyo Metropolitan and Saitama Prefecture 2013: Project based credits under the Joint Crediting Mechanism 2022: GX league (Firm-led carbon market, 440 companies joined as of Feb. 2022)
	40% compared to 2018 in 2030 Carbon neutral by 2050	2010-2011: K-CRS (CDM, REDD+) and K-VER 2015: SNational-wide ETS

Status of updated NDCs

Submitted a more ambitious NDC target	Proposed a more ambitious NDC target	Did not increase ambition in NDC target	Not yet submitted or proposed an updated NDC
Argentina (2nd NDC), Canada, EU (incl. France, Germany, and Italy), South Africa, UK (1st NDC), USA	China, Japan, South Korea	Australia, Brazil, Indonesia, Mexico, Russia	India, Saudi Arabia

Turkey's submission remains an Intended Nationally Determined Contribution (INDC) until it ratifies the Paris Agreement.

Source: Climate Action Tracker, 2021b

Timing, status, GHG coverage, and use of offsets in current G20 net zero targets

	Law	Policy Document	No target
Net zero target covers all GHGs	Canada, EU, France, Japan, UK	USA, China (2060)	Australia, India, Mexico, Russia, Saudi Arabia, Turkey
No detail in net zero target on which GHGs are covered	Germany (2045), South Korea	Argentina, Brazil, Italy, South Africa, Indonesia (2060)	

No international offsets* | Unclear or undecided | International offsets* included

*Reductions or removals outside of own borders. Note: 11 of the G20 members have a net zero target year of 2050, excl. China, Germany, and Indonesia.

Sources: Climate Watch, n.d., Energy & Climate Intelligence Unit, n.d.

China

- The world's chief GHG emitter – in 2017 alone its emissions overshadowed the EU and USA combined.
- In 2020, it consumed 8,404 million tonnes of standard coal (tce) and produced 10,240 million tonnes of CO2, accounting for 55.5% and 32.1% of the global total respectively (BP,2021)

2009	Aug.	The Standing Committee of the National People's Congress released a Resolution, Making Active Response to Climate Change, requiring that the government's work plan integrate enacted climate-change related laws.
	Nov.	The State Council announced a carbon emission reduction target: reducing the intensity of carbon emissions per unit of GDP by 40-45%, compared to the level of 2005, by 2020.
2010	Aug.	NDRC designated low-carbon development in 5 provinces and 8 cities and encourages carbon trading as part of the strategy
	Nov.	The State Council announced its 12th Five-year plan (2011-15) requiring the development of emission trading systems (ETS) in China.
	Dec.	The 12th FYP(2011-15) was announced and lists the ETS as a central part of the country's energy and climate policy
2011	Oct.	NDRC published a Notice on carbon emissions trading pilots in which Beijing, Chongqing, Guangdong, Hubei, Shanghai, Shenzhen and Tianjin were assigned as ETS pilots.
	Nov.	NDRC officially approved carbon trading Pilots in 7 provinces and cities
	Nov.	State Council decision to gradually promote the establishment of a carbon emissions trading market.
	Dec.	State Council further clarified tasks to establish the ETS during the 12th FYP
	Dec.	State Council unveiled the 12th five-year plan work program to control GHG emissions.
2012	Jun	NDRC set interim measures to support voluntary GHG reduction transactions and Indicates that CCERs can be used as offsets in the pilots
2012-2013		Design of ETS pilots, incl. review and approval of NDRC on emissions limits, allocation methods and detailed implementation plan for each pilot

2013	Jun.	Shenzhen launched its ETS.
	Nov.	Shanghai pilot and Beijing pilot started.
	Dec.	Guangdong and Tianjin launched their ETSs.
2014	Apr.	Hubei launched its ETS.
	Jun.	The last pilot was launched in Chongqing.
	Aug.	NDRC announced the National ETS will launch in 2016.
	Sep.	The NDRC released a notice on China's national climate change plan for 2014–20.
	Nov.	Joint Sino-US statement on climate change where both heads of state announced their respective action on climate change beyond 2020.
		NDRC unveiled for public comment a draft notice on 10 national standards on GHG emission accounting methods and reporting guidelines.
	Dec.	Released 'Interim Administrative Measures on Carbon Emissions Trading' The NDRC released the Provisional measures for the administration of carbon emission rights trading (high-level regulations on the national ETS).
2015	Jan.	NDRC announced the launch of the national registry for voluntary emission trading.
	Feb.	The NDRC published a notice Regarding the Fundamental conditions and operational thinking behind the promotion and establishment of the National carbon emissions rights trading market (National Market Plan).
	Mar.	Drafted Regulations on National Emissions Trading (for approving) and submitted to State Council
		The 13th FYP (2016-20) was announced and stated clearly that it will launch the national ETS in 2017.
2016	Apr	Legislative Affairs Offices of State Council listed Regulations on National Emissions Trading in the 2016 Legislative plan.
	Sep.	Ratified the Paris Agreement, and set the target of GHG mitigation to peak CO_2 emissions by 2030 at the latest, lower the carbon intensity of GDP by 60–65% below 2005 levels by 2030.

2017	Dec.	The National Development and Reform Commission announced the 'National Carbon Emissions Trading Market Construction Plan' (Power Generation Industry) marking the official launch of the national carbon market.
2018	Mar.	Responsibility for addressing climate change and developing the carbon market was transferred from the National Development and Reform Commission (NDRC) to the Ministry of Ecology and Environment (MEE).
2019	May	The Ministry of Ecology and Environment issued the 'Notice on Doing a Good Job in Submitting the List of Key Emission Units in the Power Generation Industry and Related Materials in the National Carbon Emissions Trading Market' (27th) to prepare for the allocation of quotas, system account opening and market testing.
2020	Dec	'Measures for the Administration of Carbon Emissions Trading (for Trial Implementation)' released (effective February 1, 2021).
2021	Mar	'Interim Regulations on Carbon Emissions Trading Management (Revised Draft)' released.
	May	Announcement of 'Carbon Emission Rights Registration Management Rules (Trial)', 'Carbon Emissions Trading Management Rules (Trial)' and 'Carbon Emissions Settlement Management Rules (Trial)' and promulgated carbon emission registration management, trading management and settlement as management measures to support implementation rules of the 'Carbon Emissions Trading Management Measures (Trial)'.
	July	Started the National Carbon Emission Trading Market officially

National ETS of China

Coverage
- Gas: CO2
- Sectors: Power

Allocation methods
- Free allocation: Benchmark
- Auctions : 0% (Free allocation), will apply non-gratuitous allocation in 2021-2025

Covered entities
- Minimum emissions of 26,000 tons of carbon dioxide equivalent (comprehensive energy consumption of about 10,000 tons of standard coal) in any year from 2013 to 2019, as well as enterprises that meet the carbon emission verification results of other economic organizations
- 2,225 key emitters in the power generation sector for 2019–2020, including both power generators (including cogeneration) and some industrial enterprises with their own power plants (MEE, 30 December 2020)

2020 : Power 5.7%, Industry 75.3%, Building 6.1%, Transport 0.9%, Waste 11.6%, Public services 0.3%

Shandong, with 338, followed by 216 in Jiangsu, 168 in Inner Mongolia, 141 in Zhejiang and 120 in Henan

The NDRC plans to extend coverage to eight sectors as soon as possible

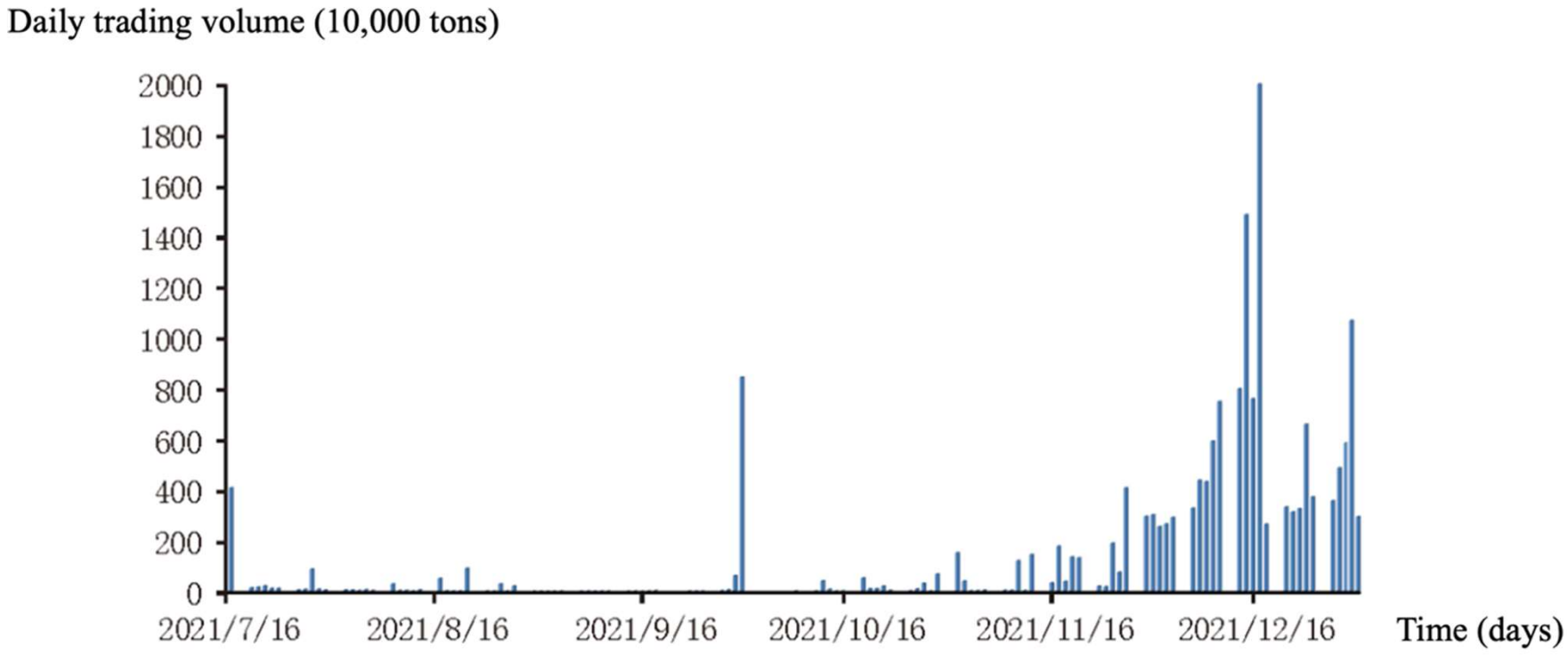
Carbon market of national ETS of China

- The national carbon market operated for 114 trading days from the launch of trading to the date of compliance by December 31.
- On July 16, 2021 (the first day of carbon trading), the transaction price was 51.2 yuan/ton. It rose sharply in mid-December and surpassed the market's first-day price on December 31, reaching 60.4 yuan/ton.
- The average daily transaction price of the national carbon market fluctuated in the range of 40–60 yuan/ton (the average transaction price was 42.8 yuan/ton)

Change in average daily transaction price in national carbon market
(Source: Wang and Li, 2022)

- 179 million tons (cumulative trading volume), with a total transaction value of about 7.684 billion yuan had been traded.
- Daily trading volume was also very high in the period leading up to the end of the compliance cycle.

Fluctuation of trading volume of national carbon market
(Source: Wang and Li, 2022)



Korea

- In 2020, the total CO2 is 701million tonnes of CO2 (MOE of Korea,2022).
- Korea was exempted from the GHG reduction obligation in the first commitment period of the Kyoto Protocol (2008–2012). However, it was widely understood that it would be classified into the group with obligations for GHG reduction in the second commitment period (post-2013) and that preparations therefor should begin.

2007	December	Established 4th 'National Countermeasures on Climate Change'
2009	January	Announced 'New growth engine vision and development strategy'
	November	Pledged 'National GHG mitigation target by 2020'
2010	January	Enacted the 'Basic Law on Green Growth'
	July	Implemented pilot project of ETS for public sector
	November	Released preliminary K-ETS proposal
2011	April	Submitted second version of K-ETS proposal to parliament
2012	May	Approved 'Act on Allocation and Trading of Greenhouse Gas Emission Allowances'
	June	Implemented pilot project for industry and power sectors
	November	Clarified 'Enforcement Decree of ETS Act'
2013	February	Launched 'Task force' to develop guidelines and allocation method
	May	Formed 'Joint working group' of experts from industry, research institutes, and academia for determining emission allowances
2014	January	Appointed 'S. Korea Exchange (KRX)' as carbon trading marketplace
		Established 'National GHG Emission Reduction Roadmap by 2020' and 'GHG ETS Basic Plan'
	May	Published 'National GHG Emission Allocation Plan'
	September	Finalized 'Allowance Allocation Plan' for the first phase (2015–2017)
	December	Allocated allowances for each entity

2015	January	1st phase started
2016	June	Announced 'National GHG mitigation target by 2030'
		Reorganized the response system for climate change and ETS
	December	Established a 'Basic plan for responding to climate change' and 'National GHG Emission Reduction Roadmap by 2030'
2017	January	Released '2nd Basic Plan' proposal
	August-September	Decision to revise the 2030 National GHG Emission Reduction Roadmap and form a working group
	December	Released '2nd Allowance Allocation Plan(2018–2020)'
2018	January	Revised the government structure: MOEK is the main authority
		2nd phase started
	April	Launched a carbon trading market council
	May	Announced the draft of revised 2nd Allowance Allocation Plan (2019–2020)
2019	January	First auction
	December	Released 3rd Basic Plan proposal
2020	September	Announced 3rd allowance allocation plan (2021-2025)
2021	January	3rd phase started

National ETS of Korea

Coverage

- 6 Gases: CO2 , CH4 , N2O, SF6 , PFCs, HFCs
- 6 Sectors: Power, Industry, Building, Transport, Waste, Public services

Allocation methods

- Free allocation: Grandfathering, Benchmark (BM)
- Auctions : 0% (Phase 1) ➔ 3% (Phase 2) ➔ 10% or more (Phase 3) ➔ ? (Phase 4)

Covered entities

- Total average annual GHG emissions for the past 3 years

125,000t or more for entities / 25,000t or more for business establishments

- Number of final allocation entities

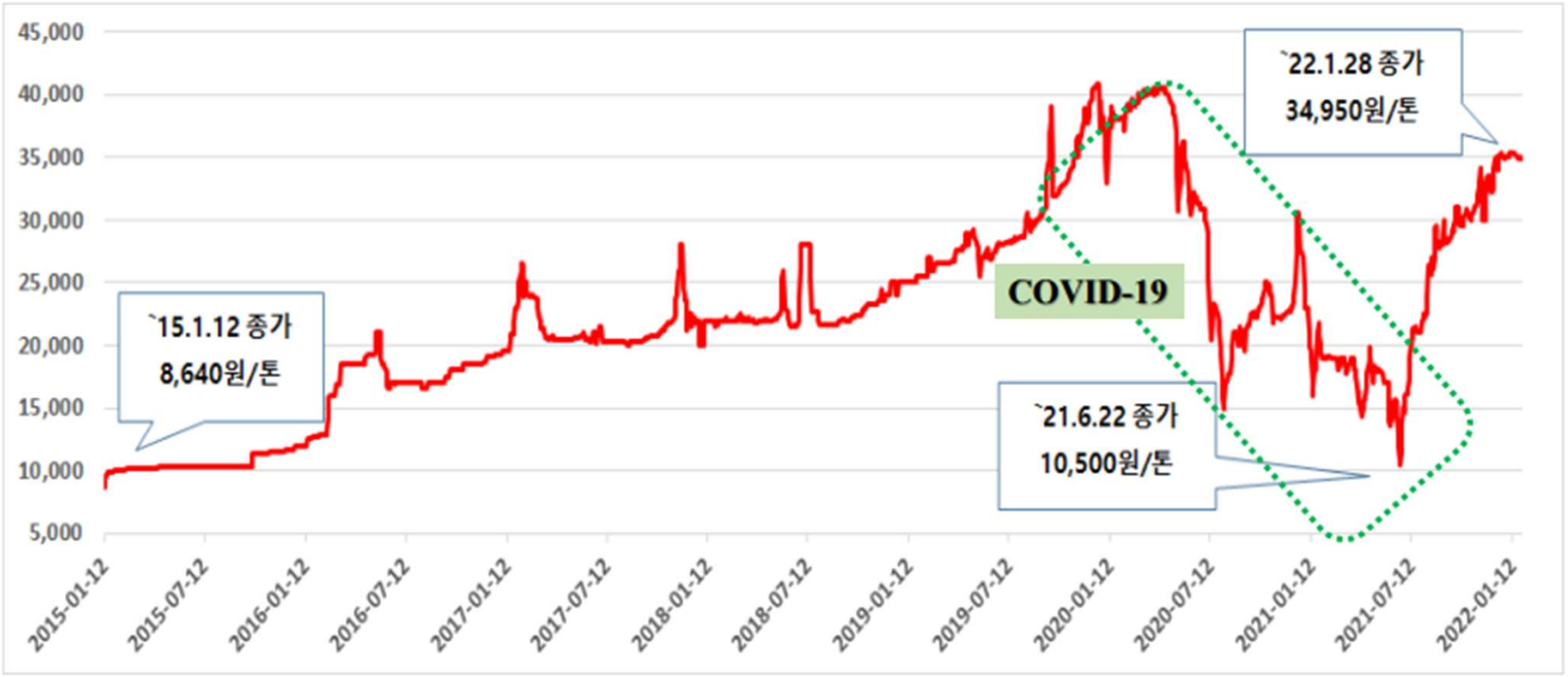
522(2015) ➔ 560(2016) ➔ 591(2017) ➔ 586(2018) ➔ 610(2019) ➔ 636(2020), 21.8% ↑

2020 : Power 5.7%, Industry 75.3%, Building 6.1%, Transport 0.9%, Waste 11.6%, Public services 0.3%

	Phase1				Phase2			
	2015	2016	2017		2018	2019	2020	
Final allocation MtCO2e	540.1	560.7	585.5	1,686.3	593.5	563.3	562.5	1,719.3
Certified emission MtCO2e	542.7	554.3	571.9	1,668.9	601.5	587.9	554.4	1,743.8
Compliance results	99.8%	100%	99.7%		99.8%	99.8%	99.8%	

Carbon market of national ETS of Korea

Price Trend of Korea Allowance Unit (KAU)



Source: Korea Exchange(KRX), 2021 Carbon Market Operation Report, 2022.04.

Recited from a presentation material by Cho Young Sung at AAERE2022

Japan

- The “Action Plan for Prevention of Global Warming”, which was promulgated on October 13, 1990, is a plan of action aimed at clarifying Japan's stance in contributing to the international framework dealing with climate change.
- Japan's determination to meet the long-term, ongoing national goals and direction related to global warming measures can be attributed to the “Global Warming Measures Promotion Plan”, enacted by the Global Warming Countermeasures Headquarters in June 1998

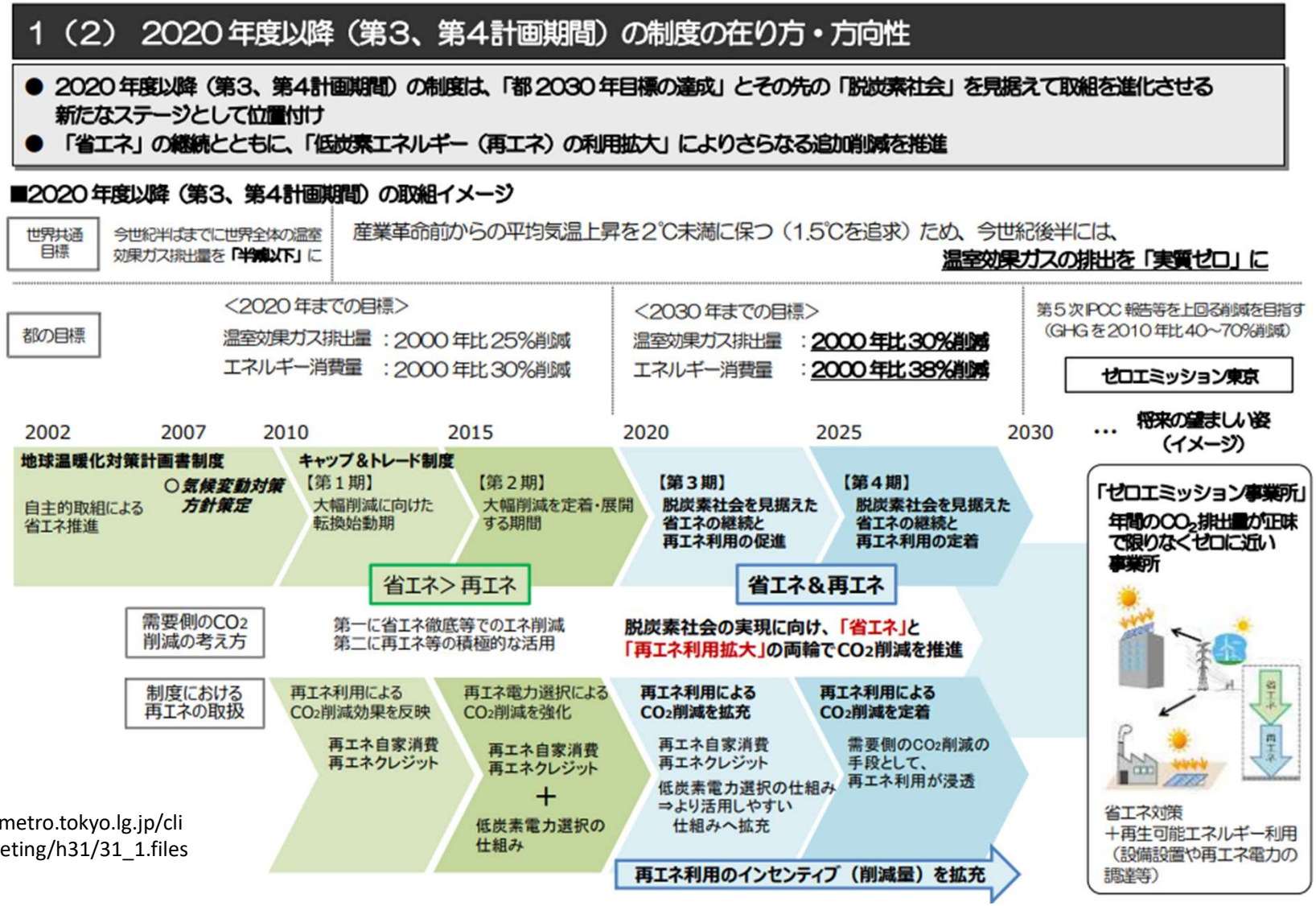
年度	内容	環境省小委員会・検討会
1997	京都会議COP3 「日本、2008～2012年6%削減(1990年比)」	
2001	環境省が環境税の検討開始	中環審地球温暖化対策税制専門委員会
2004	(7月) 環境省が環境税要望　※以来、2012年度に導入されるまで毎年要望	中環審施策総合企画小委員会
		中環審環境税の経済分析などに関する専門委員会
2007	(6月) 安倍総理　ハイリゲンサミット 「2050年世界半減を世界共通の目標」	
2008	(6月) 福田総理 「日本2050年60～80%削減」 (11月)温室効果ガス排出削減・吸収量をオフセット・クレジット(J-VER)制度開始 ※J-VER: Japan Verified Emission Reduction	
2009	(6月) 麻生総理 「日本2020年15%削減(2005年比)」 (9月) 鳩山総理 「日本2020年25%削減(1990年比)」	中環審グリーン税制とその経済分析などに関する専門委員会
2010	政府税制調査会で地球温暖化対策のための税について本格的に議論 (4月) 東京都キャップアンドトレード	
2012	(3月) 平成24年度税制改正法案可決、地球温暖化対策のための税の導入決定 (4月) 埼玉県キャップアンドトレード (10月) 地球温暖化対策のための税導入	中環審国内排出量取引制度小委員会 国内排出量取引制度の課題整理に関する検討会
2013	(4月) 国内クレジット制度及びJ－VER制度を統合してJ－クレジット制度移行	
2015	(4月) 日本2030年26%削減(2013年比) (9月) 持続可能な開発目標(SDGs) (12月) パリ協定採択　※2016年11月発行	カーボンプライシングに関する検討会
2016	(4月) 地球温暖化対策のための税の3段階目の引き上げ完了	中環審カーボンプライシングの活用に関する小委員会
2019	(7月) 環境省がカーボンプライシングに関する専門的・技術的な気論の必要性について税制改訂要望に明記	
2020	(10月) 菅総理 「日本2050年排出実質ゼロ」	(経済産業省)世界全体でのカーボンニュートラル実現のための経済的手法などのあり方に関する研究会
2021	(4月) 菅総理 「日本2030年46%削減(2013年比)」	
2022	(2月) GXリーグ	

Regional Cap and Trading Scheme-(1)

対象事業所	・年間のエネルギー使用量（原油換算）が1,500kL以上の事業所（約**1,200**事業所）
削減計画期間	・第一期：2010～2014年度（履行期限　2016年9月末） ・第二期：2015～2019年度（履行期限　2021年9月末）
削減義務率	・第一期：オフィスビル等　**8%**、工場等　**6%** ・第二期：　〃　　**17%**、　〃　　**15%** ✓病院、データセンター等の削減義務率の緩和 ✓中小企業等は削減義務対象外
基準排出量	・（原則）2002年度から2007年度までの連続３か年度平均
検証	・毎年度の排出量の報告等に、第三者機関による検証を義務付け
推進体制	・統括管理者、技術管理者の選任義務
低炭素電力等の選択	・第二期：「低炭素な電気事業者」から電気等を購入した場合、義務履行に利用できる仕組みの導入
不遵守時の措置	・削減義務未達成の場合「義務不足量×1.3倍」の削減命令 ⇒ 命令違反の場合　罰金、違反事実の公表等

図1　キャップ＆トレード制度の概要　出典：東京都

Regional Cap and Trading Scheme-(2)



https://www.kankyo.metro.tokyo.lg.jp/climate/large_scale/meeting/h31/31_1.files/bassui.pdf

Summary of carbon market scheme of China, Japan and Korea

		China	Japan		Korea
Level of government jurisdiction involved		National	Regional		National
Type of policy instrument		cap and-trade	cap and-trade		cap and-trade
Government Departments		Ministry of ecology and environment	Ministry of the Environment		Ministry of Environment, Ministry of Economy and Finance
Law		'Measures for the Administration of Carbon Emissions Trading (for Trial Implementation)'	Basic Act on Global warming Countermeasures		'Act on Allocation and Trading of Greenhouse Gases Emission Allowances'
Gas coverage		CO_2	CO_2		CO_2, CH_4, N_2O, PFCs, HFCs, SF_6
Coverage and proportion		45%	20% (Regional)		74% (National)
			Tokyo	Saitama	
Phase and compliance period	1st phase	2021~	2010-2014	2011-2014	2015-2017
	2nd phase		2015-2019	2015-2019	2018-2020
	3rd phase		2020-2024	2020-2024	2021-2025
Allocation or auction of allowances		Free allocation (Benchmarking)	Baseline approach		Phase 1: Grandfathering approach (3 sectors based on benchmark approach), 100% Free allocation Phase 2: Expansion of benchmark approach, 97% Free allocation Phase 3: The fixation of benchmark approach, 90% Free allocation
Sector coverage		Initially, power generators only. To be followed later by petrochemicals, chemicals, building materials, iron and steel, non-ferrous metals, paper production, domestic aviation, and new energy vehicles	Commerce and industry		Phase 1: power, industry, buildings, waste, and transportation (domestic aviation) Phase 2: heat and power, industry, buildings, transportation, waste sector, and the public sector. Phase 3: heat and power, industry, buildings, transportation, waste sector, and the public sector.
Target entities		Mandatory for entities that fall within the inclusion threshold Inclusion Threshold: Entities with annual emissions of up to 26,000 t/CO_2 (energy consumption of more than 10,000 TCE) in any year over the period 2013–2019 are covered by the national ETS	Facilities that consume the energy equivalent to at least 1,500kL of crude oil per year.	Facilities that consume the energy equivalent of at least 1,500kL of crude oil for three consecutive years	Companies >125,000 tCO_2/year or Installations >25,000 tCO_2/year in average of past three years
Liable entities		About 2,225	about 1,600 facilities	600 facilities	About 680
Flexibility	Banking	○	○		○
	Borrowing	×	×		○
Offsets/Credits		Domestic only using: Chinese Certified Emission Reduction Credits (Expected from the third phase, from article 3 of the Work Plan) (5%)	Four types of offset credits are permitted: Small and mid-size facility credits, Small and mid-size facility credits, Renewable energy credits, Saitama credits (via link)		Domestic (5%)and oversea offset credit(5%)
Penalty		Ex-post adjustment is permitted, but the exact mechanism is not publicly disclosed yet.	The governor orders the facility to reduce emissions by the amount of the reduction shortfall multiplied by 1.3. Any facility that fails to carry out the order will be publicly named and subject to penalties (up to JPY 500,000 [USD 4,683]) and surcharges (1.3 times the shortfall).	If the reduction target is not achieved, the name of the company is made public and the insufficient reduction amount added to the reduction amount of the following compliance period.	3x average market price of compliance year and max. KRW 100,000/t-CO_2 (about USD 90/t-CO_2)

Carbon market linkage

Context of carbon market linkage in the Paris Agreement

- Article 6.2 of the Paris Agreement provides a foundation for linkage by recognizing that parties to the agreement may "choose to pursue voluntary cooperation in the implementation of their" NDCs through "the use of internationally transferred mitigation outcomes" (ITMOs) (UNFCCC, 2015).
- Paragraph 6.2 of the agreement outlines a framework for recognizing traded obligations (called 'internationally transferred mitigation outcomes') so that double counting is avoided because a party to the agreement is allowed to include traded reductions undertaken by another party to count toward the first party's NDC.
- Paragraph 6.3 states that: 'The use of internationally transferred mitigation outcomes to achieve nationally determined contributions under this Agreement shall be voluntary and authorized by participating parties.
- To be clear, there are three conceptually— and operationally—distinct aspects of international policy linkage:

(i) (the focus of our analysis) provisions in Article 6.2 of the Paris Agreement and related guidance that can facilitate international linkage, by providing, for example, for ITMOs to be used as an accounting mechanism when "compliance" with NDCs is measured;

(ii) agreements between two or more jurisdictions to recognize emission reductions generated in the other jurisdictions;

and (iii) two or more compliance entities, one in each of the linked jurisdictions, engage in an exchange, for example, permitting allowances to move between cap and-trade systems.

Linking the EU ETS system with other systems

- The EU ETS covers the European Union Member states, as well as Iceland, Liechtenstein and Norway. It is possible to link the EU ETS to other compatible national carbon markets.
- EU ETS is linked to Switzerland ETS effective from 2020. The small amount of facilities in the Swiss ETS had limited the opportunities for developing the carbon market, and linking it with the EU ETS has increased the flexibility of reaching the climate targets. It was necessary to include aviation and fossil-thermal power plants under the Swiss ETS to make the two systems compatible.
- Creating a broad international carbon market can lead to global cooperation, encouraging other countries to react and make a move towards reaching climate targets. In case the carbon prices are closer to each other, it is more likely to avoid carbon leakage, so a decrease in the emissions in the domestic country will less likely lead to an increase of the emission in another country through moving production there.

- Federal Office for the Environment FOEN - Linking the Swiss and EU emissions trading systems. https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/reduction-measures/ets/linking-swiss-eu.html
- European Commission: Agreement on linking the emissions trading systems of the EU and Switzerland. https://ec.europa.eu/commission/presscorner/detail/en/IP_19_6708

Literatures

- Most of the existing studies are EU-ETS cases;
- Several existing studies look into the benefits of such carbon market linkage strategies from various angles, through mostly economic comparative analysis of connected countries, and of the different types of linkage;
- Most of them address the effect in terms of economic (cost effectiveness reduction cost by increasing the number of market participants, improved liquidity in the market and mitigation leakage and competitiveness concerns) (Anger, 2008, Carbone et al., 2009, M. A. Mehling et al., 2018, Doda et al., 2019, Oliveira et al., 2019, Diniz Oliveira et al., 2019) , distributional impacts (Flachsland et al., 2009, Fæhn & Yonezawa, 2021, Holtsmark & Midttømme, 2021), and emission reduction (B. Holtsmark & Weitzman, 2020) of connected countries;
- Other benefits of linking cap-and-trade markets in terms of political view (Burtraw et al.,2013). It facilitates political agreement on more ambitious reduction target (Lazarowicz, 2009);
- A greater number of linked ETS should yield greatest benefits.

Linkage type and existing linkage markets

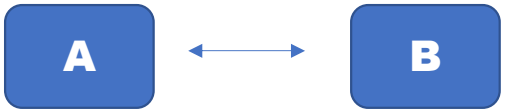
- The term “linking” refers to a formal relationship that allows the exchange of emissions allowances or offsets between different trading programs, implying that permits issued in one system can be traded internationally for use of the other.
- In this market context, a formal link may take several forms, *unilateral link, bilateral link and multilateral agreements* (Judson et al., 2009, M. Mehling & Görlach, 2016).

Unilateral link

- Two cap-and-trade programs directly linked but if recognition flows in only one direction and trade may occur one way;
- when one administrator recognizes allowances or credits from another jurisdiction as eligible for compliance. The main intent of these links is to reduce compliance costs.
- **Example1:** Norway’s cap-and-trade program, which was unilaterally linked to the European Union’s Emissions Trading System (EU ETS) in 2008 (ADB, 2016). Emissions allowances from the EU ETS were recognized as eligible for compliance in Norway’s cap-and-trade program, but emissions allowances from Norway’s program were not recognized as eligible for compliance in the EU ETS
- **Example2:** The initial memorandum of understanding (MOU) of the Regional Greenhouse Gas Initiative (RGGI) in the northeastern United States allowed for a unilateral link to EU ETS allowance markets conditional on the triggering of a price ceiling for RGGI allowances, but prices have never reached this ceiling, so the option has never been used.

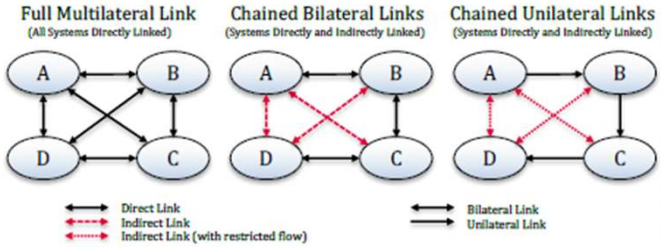
Bilateral link

- Two ways and their allowances are recognized as eligible for compliance (Judson et al., 2009)
- It can be established in a binding bilateral agreement.
- The most straight forward case of international climate policy linkage, a pair of national cap-and-trade systems in parties to the agreement.
- **Example1:** the link the European Union Emission Trading System (EU ETS) to the Swiss system, which was entered into force in 2020 (Council of the EU, 2019).
- A bilateral link is also formed through reciprocal unilateral linking.
- **Example2:** California and Quebec, the so-called Western Climate Initiative (WCI), which four US states (New York, Vermont, Oregon and Washington) and two Canadian provinces (Ontario and Manitoba) (Burtraw et al., 2013).



Multilateral link

- Any link between three or more tradings or crediting systems (M. Mehling & Görlach, 2016)
- A multilateral link can, in theory, reach universal participation, and thus become a *de facto* global carbon market.
- Direct trading between all linked systems (multidirectional trading) is not a necessary condition, as a single chain of direct links between systems will allow units to flow across all systems, including those that are not directly linked.



(M. Mehling & Görlach, 2016)

Carbon pricing forum China, Japan and Korea

- From 2016, these three countries initiated a trilateral policy dialog on carbon pricing to share the policy progress and discuss the possibility of linking carbon markets
- Governments, research institutes, universities, and companies from each country participated and discuss policy progress and regional cooperation.

CJK Carbon pricing and market linkage

1st Forum in 2016 in Beijing China
2nd Forum in 2017 in Seoul, Korea
3rd Forum in 2018 in Tokyo, Japan

A scene where representatives of Japan and China greet each other at the 3rd Forum held in Tokyo

Model analysis

Introduction

Objectives

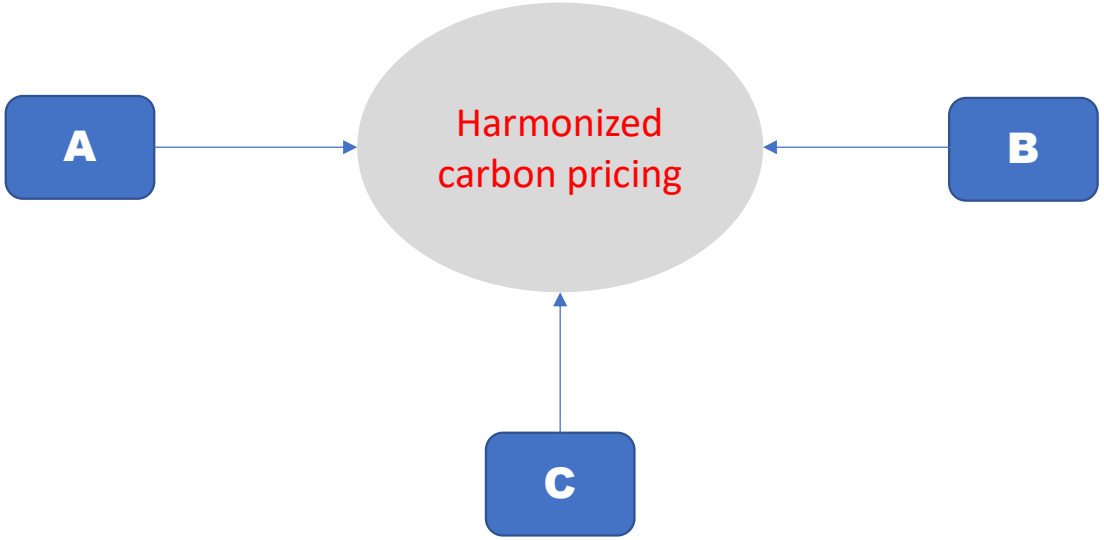
- This study aims to discuss how a harmonized carbon market would impact the economies and environments of the three countries by comparing individual carbon markets implemented for each country's decarbonisation pathway for 2030 and 2050.

Method

- Model: the latest version of E3ME (Energy-Environment-Economy Macro Econometrics Model) (vs. 6.1)
- Scenario 1: An individual markets scenario, based on the current Chinese, Japanese, and Korean national carbon targets for 2030 and pledges for net zero by 2050;
  Scenario 2: A joint carbon market of the three countries, where a single carbon price is applied to all countries ;
- The joint targets in 2030 and 2050 are the sum of reductions from national targets translated to reductions from 2018 as the base year. Sectoral coverage for carbon trading, energy-related GHGs, and recycling carbon revenues were also incorporated into the model setup.

Carbon market in the model

- In this study, for the model analysis, the linkage of the market was implemented by applying a single harmonized carbon price;
- The carbon price required for each country to achieve carbon reduction and carbon neutrality in each country's individual carbon market and the common carbon market were quantified, and their impact on each country's economic environment was analyzed.



Conceptual map of the CJK multilateral link in this study

Scenario specification-1

This analysis covers two different scenarios in addition to a baseline:

- **BA** (Baseline): Baseline with already implemented policies (excluding new policies for NDC or long-term emission reduction targets)-IEEJ OUTLOOK 2021*
  * Global and Asian energy demand forecasts released annually by the Institute of Energy Economics (https://eneken.ieej.or.jp/data/9170.pdf)
- **NAT** (National carbon market): Individual carbon markets scenario, based on the Japanese, South Korean and Chinese national carbon targets in 2030 and net zero announcements
- **CJK** (CJK joint carbon market): Joint carbon market for China, Japan and Korea to meet national targets, implementing a single set of carbon price applied to all countries.
- The joint target in 2030 is the sum of reductions from national targets translated to reductions from 2018 as a base year. The net zero date is the weighted average, by emissions, of the three countries' net zero target announcements .

Emissions reduction target in 2030 and 2050 – National markets

National	Target in 2030	Base year	Net zero year
Japan	-46%	2013	2050
China	-30%*	2020	2060
Korea	-40%	2018	2050

* China originally aims for post-peak reduction in 2030. A 30% reduction was assumed in this study.

Emission reduction target in 2030 – Joint CJK market

	Target in 2030	Base year	Net zero year
CJK market	-32%	2018	2058

Scenario specification-2

Coverage

- All sectors are assumed to be covered in carbon trading in both national and joint market cases.
- Emissions in this modelling exercise cover only energy-related and processed CO_2 emissions.
- Non-CO_2 GHG (not modelled) are assumed to fall in line with CO_2 emissions.

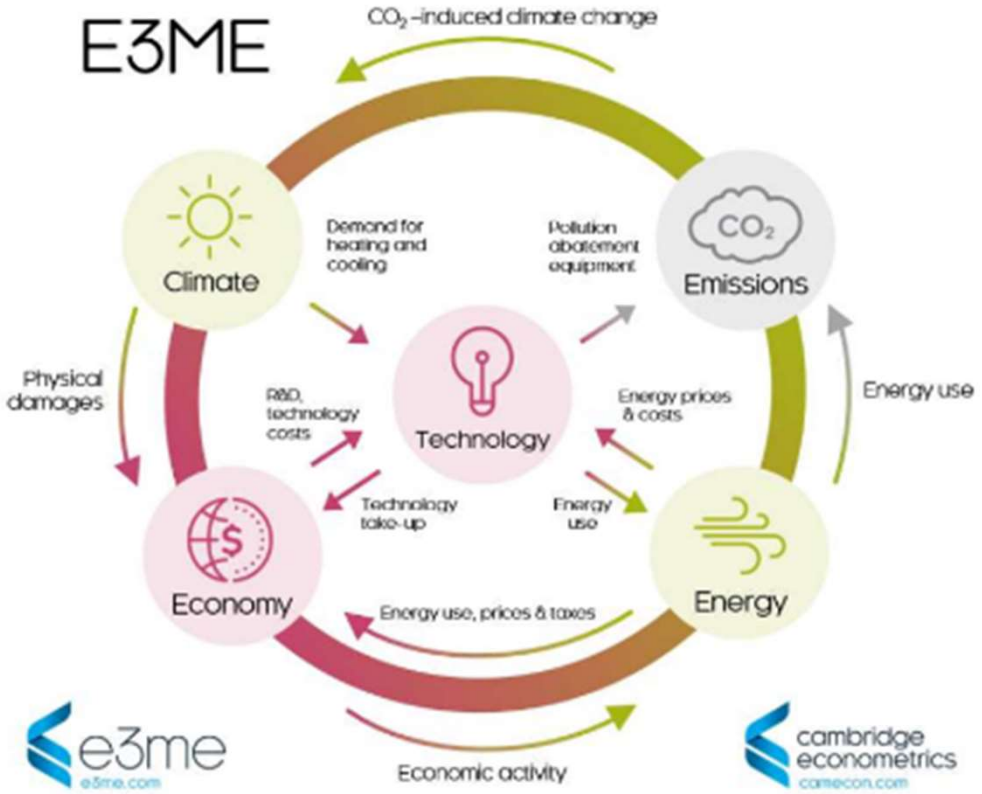
Revenue recycling assumptions

Carbon pricing is assumed to generate revenues to national government where emission reduction is taken place. The additional revenues are used in three ways, same across the two scenarios:

- 40% of total revenues used to reduce national income tax rate,
- 40% of total revenues used for lumpsum payments to households,
- 20% of total revenues used to invest in energy efficiency, subsidising renewables and kick start low carbon technologies

Methodology

- The latest version of the Energy-Environment-Economy Macro Econometrics (E3ME) model
- E3ME was developed by the Cambridge Econometrics in 1970 and has been frequently used to asses climate and energy policy through the European Commission's research framework programmes as well as IPCC, World bank and etc.
- The key distinguishing feature of the E3ME model is its macro-econometric approach .
- In practice, this means that reaching climate neutrality will not *by assumption* result in an additional burden to the economy. Instead, the economic impact depends on the use of available resources and their interaction with economic production.
- This model has a characteristic that reflects well the impact on the economy when economic entities make low-carbon technological innovation and related investments under the rise of carbon costs due to carbon taxes or carbon prices.



www.e3me.com

E3ME model (v6.1)

- Energy-Environment-Economy Macro Econometrics (E3ME) model
- Computer-based model of the world's economic, energy and the environment
- The model consists of collections of stochastic behavioural equations and accounting identities
- Based on an accounting framework and designed for projections for business and policy analysis

Detailed Coverage

- 29 regions (33 European, 26 World)
- 70/44 economic sectors and 42/28 consumption categories
- 23 fuel users of 12 fuels

Comprehensive

- whole energy, environment and economy system
- two ways feedbacks between each module
- many policy instruments

Highly Empirical

- 1970-2014 database
- 22 stochastic equations
- no prior assumptions
- econometrics specification allows for short-medium and long term analysis

Consistent

- based on system of national accounting
- input-output tables
- bilateral trade

Forward Looking

- annual projections to 2050
- behavioural equations with effects from previous outcomes
- ex-ante scenario analysis (ex-post is also feasible)

Modular

- E3: Energy, Environment, Economy and material modules
- power generation sub-module
- research can be decentralised

E3ME model dimensions

- Econometric model
  - **cover world 59 regions**, including explicit representation of all G20 countries and all EU Member States. The model has recently been expanded to cover many East Asia and South East Asia regions explicitly including Japan, China, Korea, Taiwan and Indonesia. Other ASEAN countries are grouped together.
  - based on the system of national accounts
    - includes intermediate and all components of final demand
    - detailed treatment of the labor market
    - **22 stochastic equation sets**, also covering energy and prices
  - large sectoral disaggregation: **42 industries, 28 consumption** categories
  - **12 different fuel types**, and **22 separate fuel user groups**
  - **14 atmospheric emissions**
  - long and short-term specification
  - annual solutions to 2050
- For more details see www.e3memodel.com

E3ME model (v6.1) vs CGE

- There are substantial differences in modelling approach
- The two types of model come from distinct economic backgrounds
- While they are in general consistent in their accounting, identity balances, they differ substantially in their treatment of behavioural relationships.

CGE: assumptions about optimization

CGE model favours fixing behaviour in line with economic theory.

- For example by assuming that individuals act rationally in their own self-interest and that prices adjust to market clearing rates; in this way aggregate demand automatically adjusts to meet potential supply and output levels are determined by available capacity.
- all resources are fully utilized, it is not possible to increase output and employment by adding regulation.
- Many of the assumptions that underpin CGE (and DSGE) models have been increasingly questioned as to whether they provide an adequate representation of complex real-world behaviour.

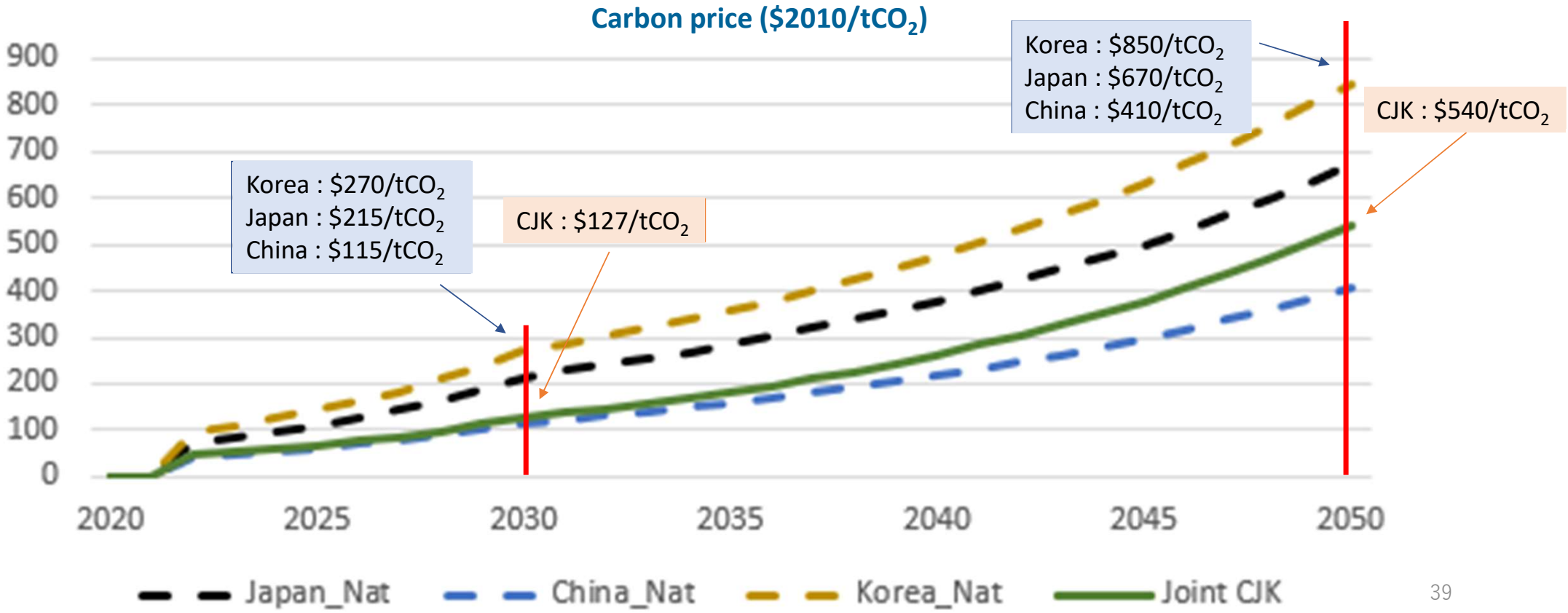
E3ME: econometric models

E3ME interrogate historical data sets to try to determine behavioural factors on an empirical basis and do not assume optimal behaviour.

- The model is demand-driven, with the assumption that supply adjusts to meet demand (subject to any constraints), but at a level that is likely to be below maximum capacity.
- E3ME allows for the possibility of unused capital and labour resources that may be utilised under the right policy conditions; it is therefore possible (although certainly not guaranteed) that additional regulation could lead to increases in investment, output and employment.
- The main drawback of the E3ME approach in comparison is its reliance on having high-quality time-series data. There is at present no equivalent to the GTAP database for time series, so a large amount of resources must be put into compiling suitable data sets.

Results- Carbon price ($2010/tCO$_2$)

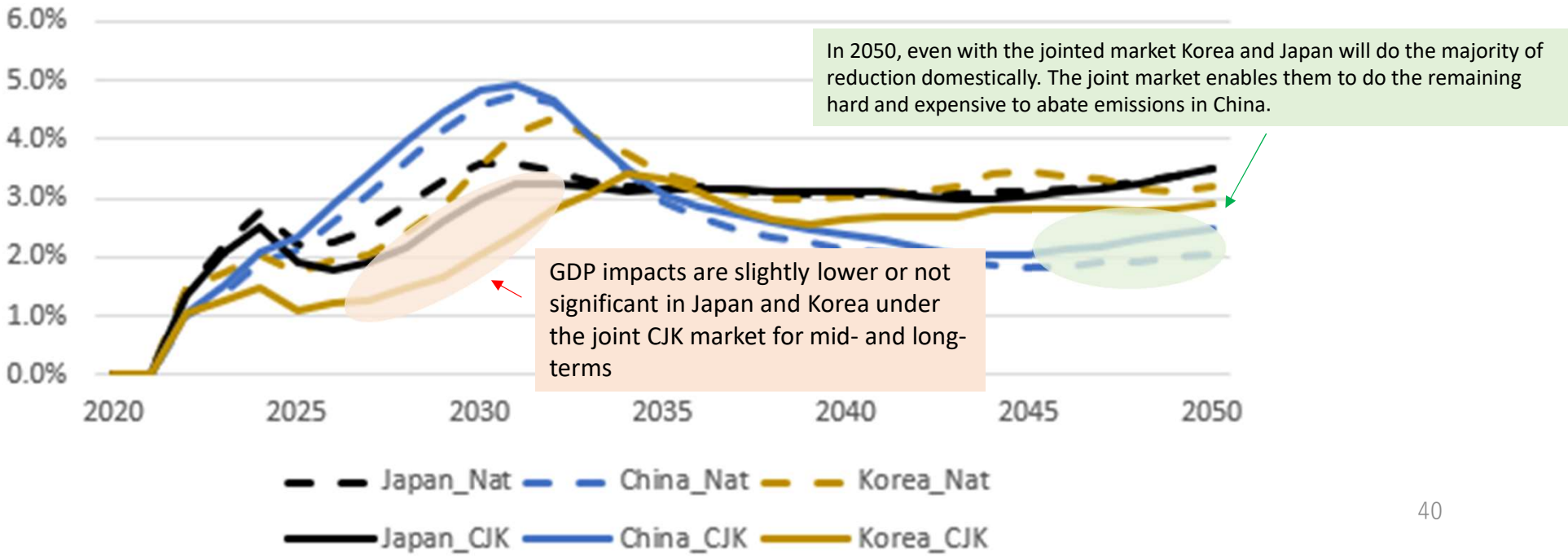
- High level of carbon price is needed to achieve emission reduction targets in all countries.
- Our results in 2030, compare to the baseline in the same year, suggest that Japan and Korea will do about 15% and 30% of their emission reductions in China respectively.
- CP level: China<CJK<Japan<Korea
- The joint market enables them to do the remaining hard and expensive to abate emissions in China.



Results- Macroeconomic impacts (1): GDP

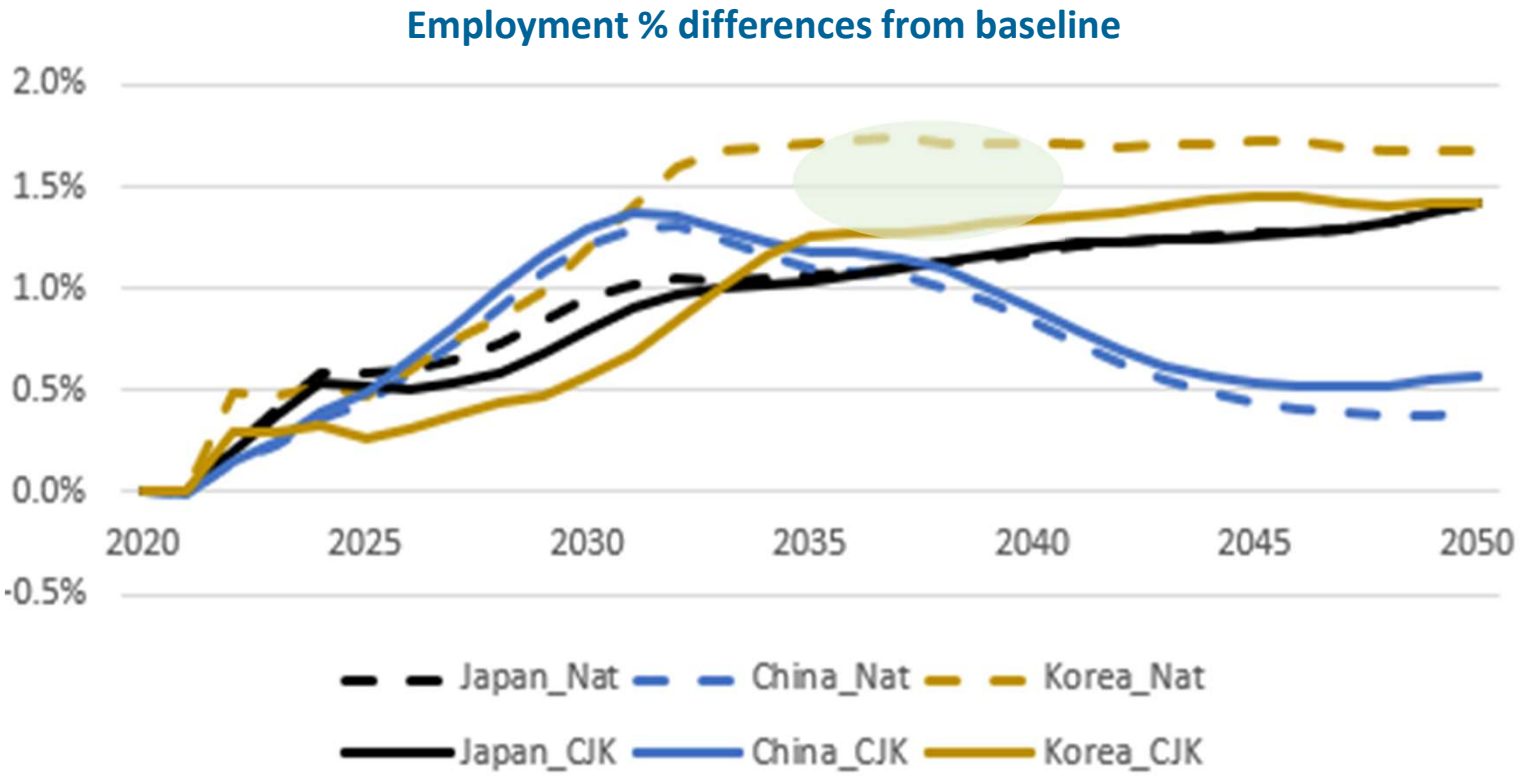
- Despite the cost-effectiveness of emission reduction when a joint carbon market is introduced (as shown in the carbon price), GDP impacts are slightly lower in Japan and Korea under the joint CJK market compared to a national scenario where carbon prices are higher.
- The reasons: use of revenues from carbon price, These revenues can be used to reduce other taxes which could create double dividends where economy experiences positive economic impacts, and also be used to subsidise or directly invest in renewable and low carbon technologies➡ missed opportunities from higher investment, learning effects, improved trade balance by not doing emission reduction nationally

GDP impacts in national vs CJK scenario, % differences from baseline



Results- Macroeconomic impacts (2): Employment

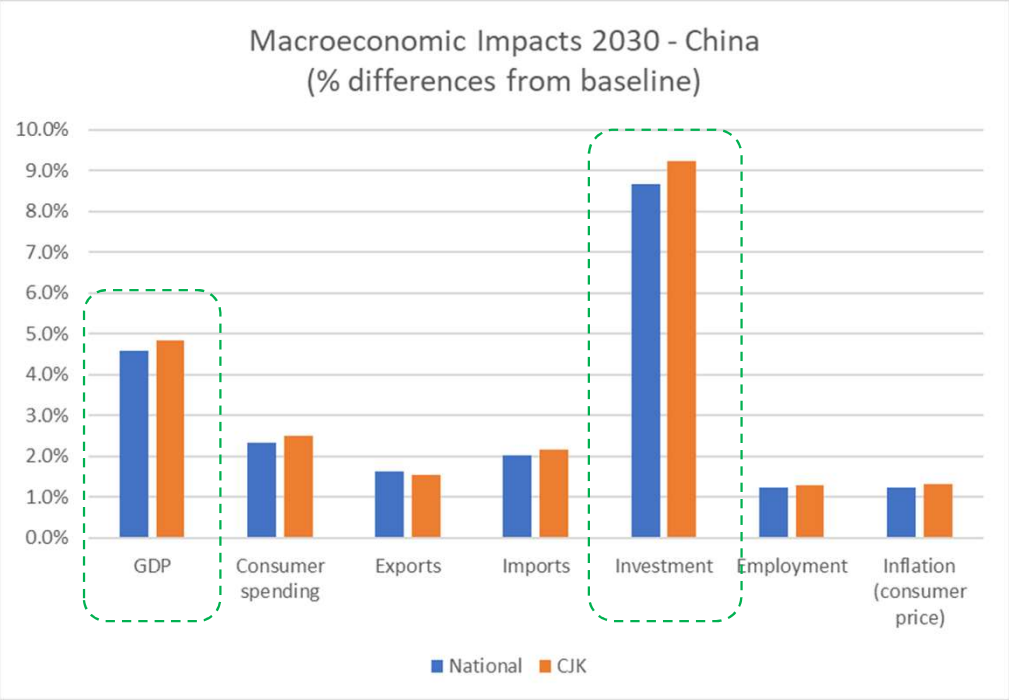
- For Japan and China, there is not much difference between the domestic market and the linked market in terms of the impact on employment.
- In the case of Korea, due to the high carbon price in the domestic market, access to the Chinese market through the linked market acts as an advantage for reducing greenhouse gas reduction costs, but the national market operation is advantageous in terms of the impact on domestic employment.

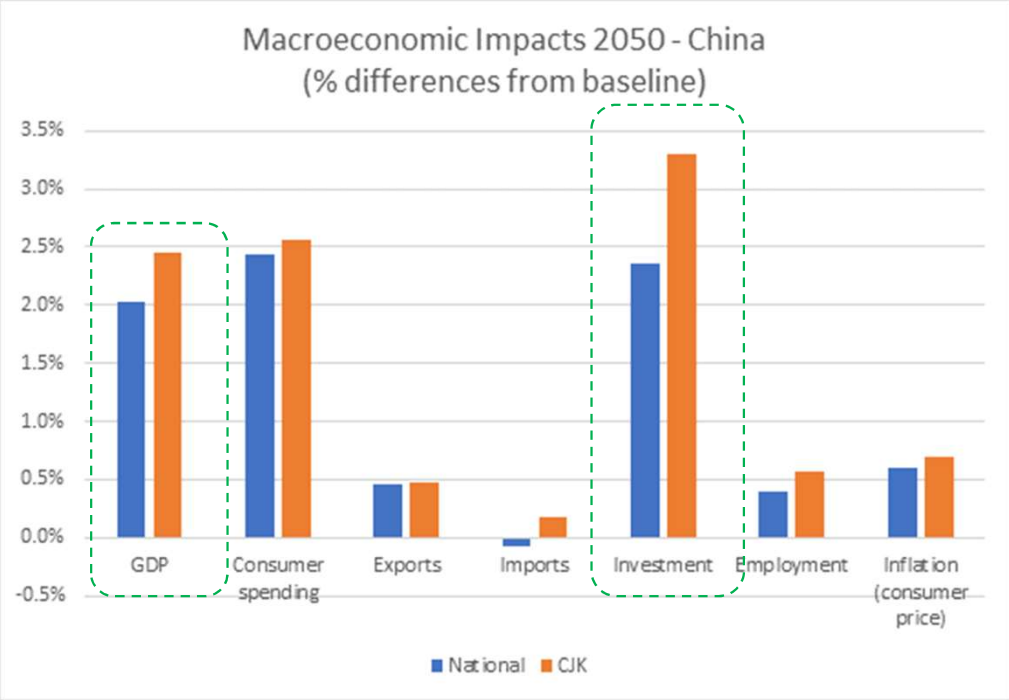


Results- Macroeconomic impacts (2):Breakdown of GDP impacts by country

CHINA

- GDP are driven by additional investment required to meet the 2030 and net zero targets.
- In the joint CJK market, China GDP is higher than the national case. China benefits from additional low carbon investment and additional carbon revenues from Korea and Japan which it uses to reduce other taxes in the economy.

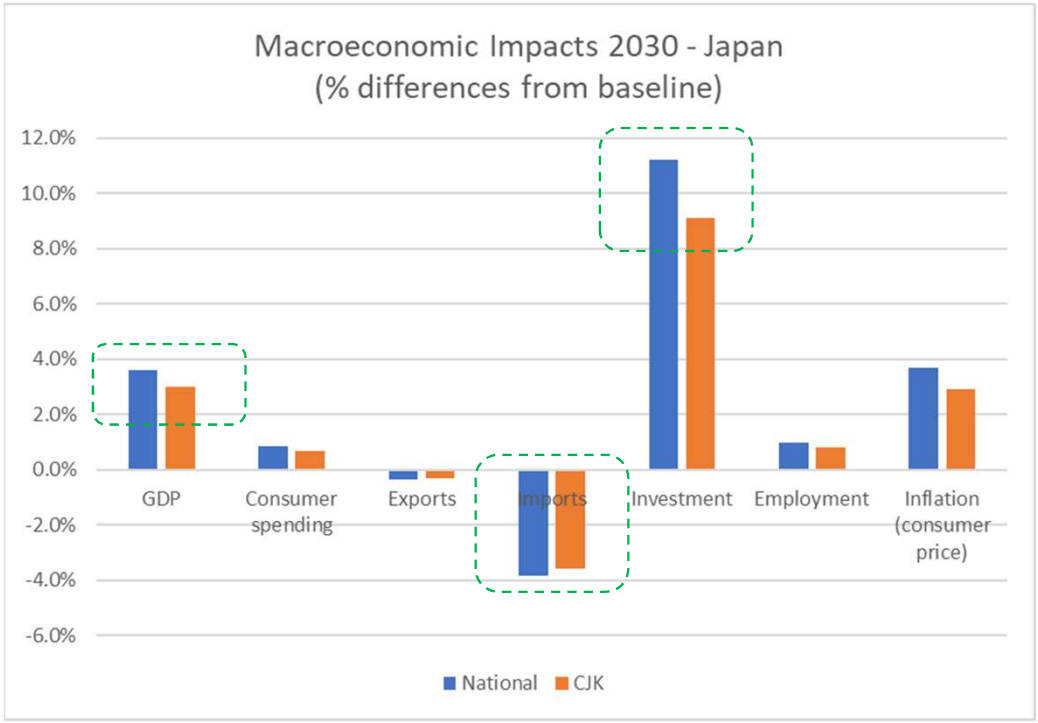


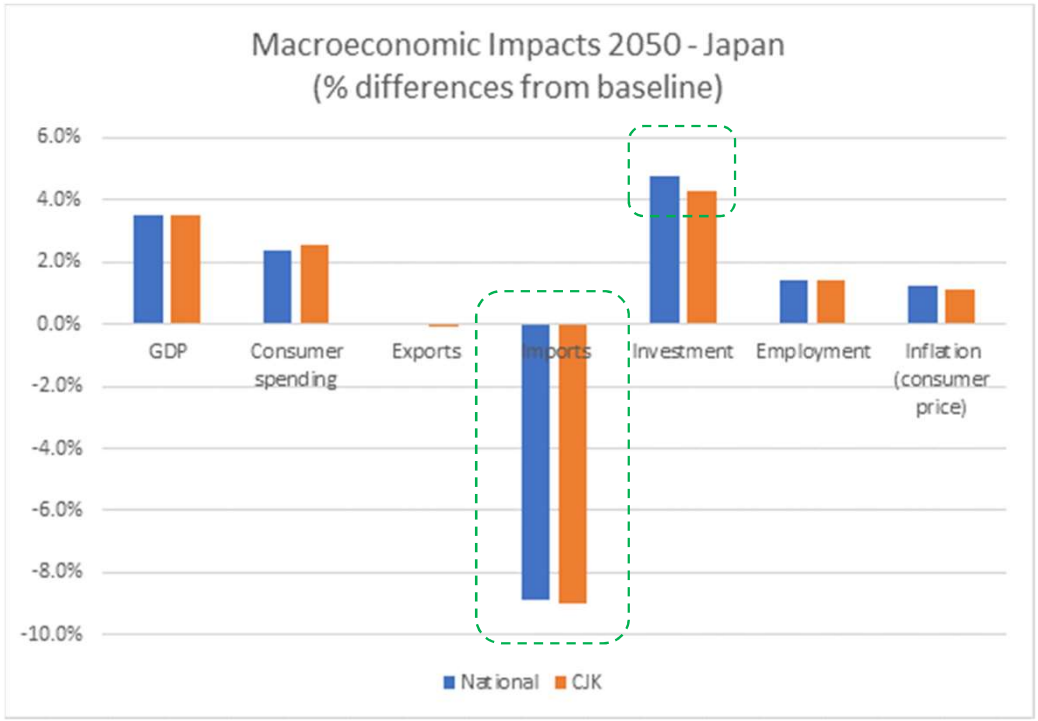


Results- Macroeconomic impacts (3):Breakdown of GDP impacts by country

Japan

- Japan benefits less under the CJK joint market scenario compared to the national target scenario. This is shown in their lower investment and consumer spending.

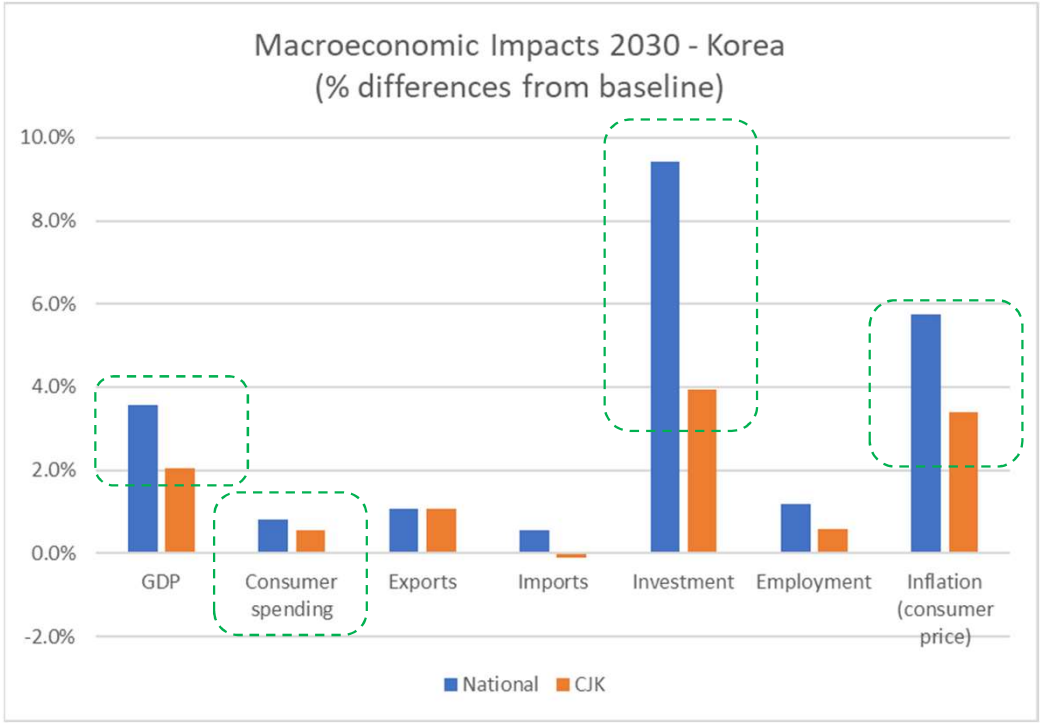


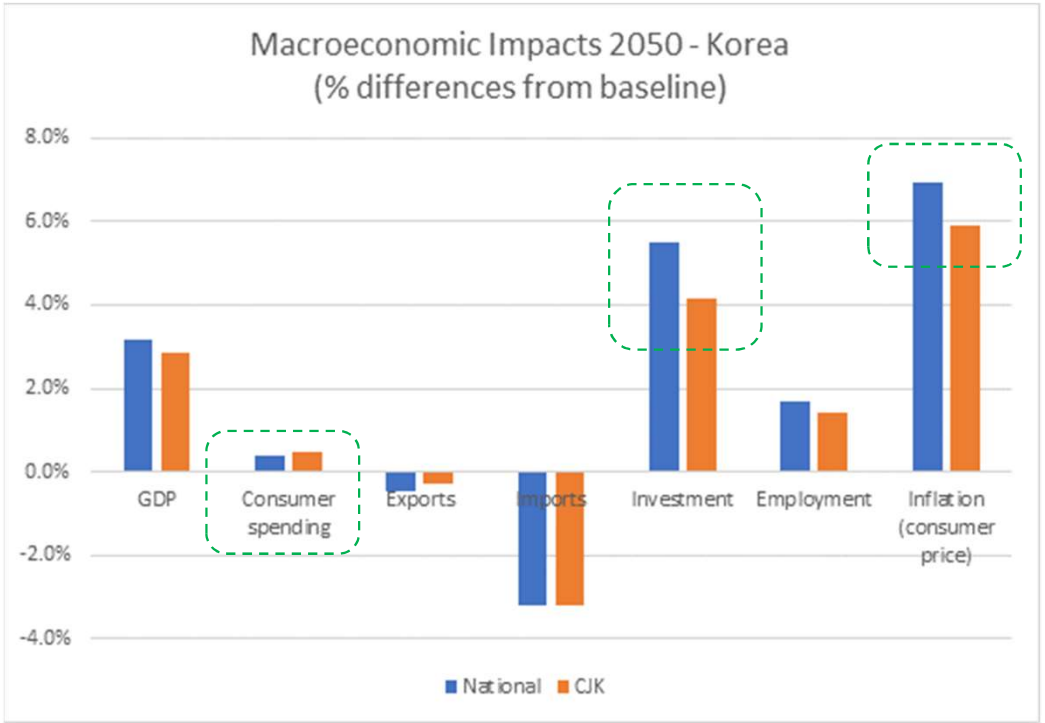


Results- Macroeconomic impacts (3):Breakdown of GDP impacts by country

Korea

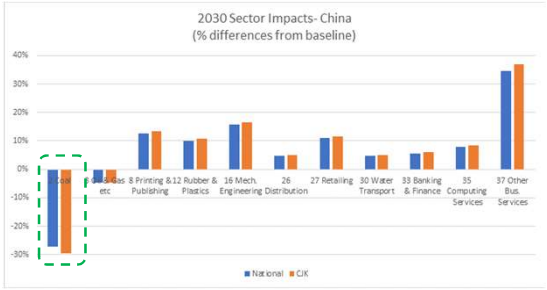
- Korea also benefit less under the CJK joint market scenario compared to the national target scenario in it GDP, lower investment as well as Consumer spending. It also experiences higher inflation relatively than China and Japan.
- One definite contributor is the low price elasticity of gas use (i.e. gas demand is relatively inelastic, much more elastic in China / Japan), combined with the high coal use in the economy. This also drives the higher price inflation: the higher carbon price is challanged through to final consumption prices leading to higher price inflation.

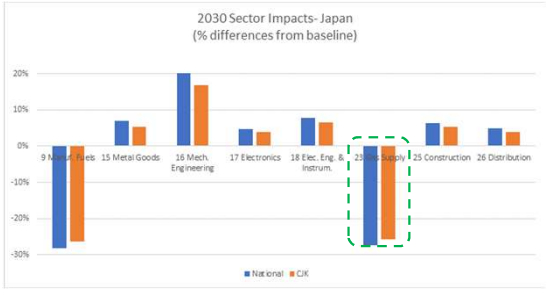


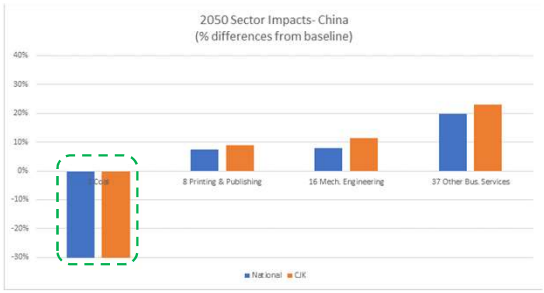


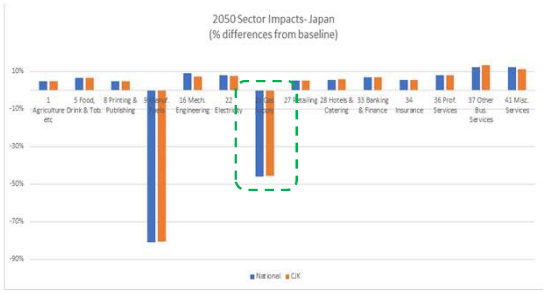
Results- Macroeconomic impacts (3):Breakdown of GDP impacts by sector

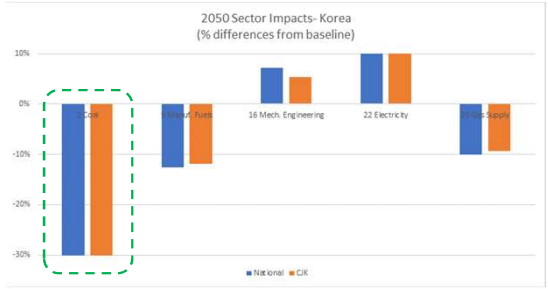
- The impact on the industries of the three countries varies. The model simulation indicated commonly, the fossil fuel-related industries in the three countries will have negative impact.
- In Japan, in 2030 and 2050, the fossil fuel-centered manufacturing sector and gas supply sector have a great impact, which their difference from the baseline are -28% and -27% in 2030, respectively, and deepens to -81% and -46% in 2050.
- In China, coal-related sectors are reduced by 30% in 2030 and have a negative impact of nearly 60% in 2050 from their baseline.
- Similary, in the case of Korea, the coal -related industries are negatively affected -24%by 2030. A noteworthy for Korea is that the negative impact is alleviated under the linkaged carbon market, which are not seen in China and Japan.











Conclusion and further study

- Carbon prices for Korea and Japan are almost half of the rate that they would otherwise pay in individual carbon markets.
- A joint market between China, Korea and Japan would allow for emission reduction to take place in China where carbon prices are cheaper. If the policy aim is to minimise costs to consumers and businesses then a joint carbon market will deliver this.
- However, the goal of minimizing costs alone ignores the potential benefits of low carbon transition, which has not been addressed fully in existing studies.
- This is due to the fact that low carbon transition includes additional low carbon investment, knowledge gained from the transition, energy savings potentials, and reduction in fossil fuel imports. These benefits can only happen in a country if it takes domestic action (like a carbon tax or carbon pricing) to reduce emissions.
- Moreover, a carbon tax or carbon pricing can generate revenues to subsidize low carbon investment and reduce other distortive taxes in the local economy. By carbon emission permits from another country, individual nations lose these potential revenues.
- GDP results show that despite lower carbon pricing, Korea and Japan are not reaping the benefits of additional investment and GDP outcomes are lower under the joint CJK scenario. China, in contrast, is benefiting from a joint market.
- By sector impact, the model simulation indicated commonly, the fossil fuel-related industries in the three countries will have negative impact due to the high price of carbon.

Conclusion and further study

- This study highlights potential outcomes from a joint carbon market between China, Korea and Japan.
- However there are several shortcomes: only carbon pricing for NDC and carbon neutrality, assumption that all revenues raised are used to reduce taxes and subsidize low carbon technologies, sampled market design, fully auctioned allowance, and etc.
- The nest study includes

  - ✓ Examination of additional policies such as energy mix, transport policies (push for EVs) and industry/household energy efficiency measures along with carbon pricing.
  - ✓ Investigation of alternative revenue recycling mechanisms like the use of revenues to pay off existing public debt or directly to support the low carbon transition.
  - ✓ Investigation of alternative trading schemes devised by individual countries (sector coverage, free allocation rate, offset credit).
  - ✓ and the impact analysis of the European carbon policy trends CBAM (Carbon Border Adjustment Mechanism) .

Thank you very much

suksunhee@nagasaki-u.ac.jp