BACKGROUND PAPER

Green Revenues for Greener Asia

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CONTENTS

ABSTRACT

Asian countries have been facing various environmental problems, ranging from air and water pollution to climate change. At the same time, many people seek higher income and further economic development, which requires more government revenue. This paper introduces carbon pricing, environmental tax, and emissions trading schemes, all schemes that can help achieve the two objectives: environmental conservation and revenue raising. The paper reviews experiences from the implementation of these policy instruments from the perspective of raising revenue and the effectiveness in environmental conservation with focus on Asia. Specifically, the experiences in India, Japan, the Republic of Korea, the People's Republic of China, and Singapore show that governments can raise revenue while reducing emissions. We conclude our paper with policy implications.

ABBREVIATIONS

ADB	–	Asian Development Bank
ASEAN	–	Association of Southeast Asian Nations
BOD	–	biological oxygen demand
CBAM	–	Carbon Border Adjustment Mechanism
CDM	–	Clean Development Mechanism
CO_2	–	carbon dioxide
EPT	–	Environment Protection Tax
EU	–	European Union
EU ETS	–	European Union Emissions Trading Scheme
GDP	–	gross domestic product
GHG	–	greenhouse gas
GPCB	–	Gujarat Pollution Control Board
GST	–	goods and services tax
FY	–	fiscal year
HAP	–	household air pollution
ICAP	–	International Carbon Action Partnership
JCM	–	Joint Crediting Mechanism
KETS	–	Korea Emissions Trading Scheme
kg	–	kilogram
km	–	kilometer
KZ ETS	–	Kazakhstan Emissions Trading Scheme
MRV	–	monitoring, reporting, and verification
NeML	–	National Commodities and Derivatives Exchange e-Markets Limited
NOx	–	nitrogen oxides
OBA	–	output-based allocation
PDF	–	pollutant discharge fee
$PM_{2.5}$	–	particulate matter
PRC	–	People's Republic of China
RGGI	–	Regional Greenhouse Gas Initiative
ROK	–	Republic of Korea
SO_2	–	sulfur dioxide
tCO_2e	–	metric tons of carbon dioxide equivalent

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I. INTRODUCTION

Asian countries have been facing various environmental problems ranging from deforestation to air and water pollution. Governments of Asian countries must make effort to address these environmental issues. Recently, the risk of climate changes has become more severe and apparent as the region has experienced some extreme weather events. After the Paris agreement ratification in 2016, most Asian countries now face the obligations to control their emissions and pledge their target to United Nations Framework Convention on Climate Change. To achieve their pledges, Asian countries must take drastic actions to reduce greenhouse gas (GHG) emissions, which is proving to be a challenging task.

At the same time, emissions reductions measures must not hinder economic growth. This is especially so for middle-income and low-income countries where many people seek higher income and further economic development. To achieve economic growth, governments need additional revenues to implement necessary policies and regulations.

Environmental policy instruments, if they are properly designed, can help achieve these two objectives: environmental conservation and revenue raising. Since these policy instruments can contribute to both environmental conservation and revenue raising, we can call it revenue-raising green policy instruments. In this context, carbon pricing such as emissions trading schemes (ETSs) or carbon tax is becoming a major policy instrument to address the climate change while raising public revenue. In Asia. Japan, the Republic of Korea (ROK), and the People's Republic of China (PRC) are the front runners of ETSs in this region (Arimura et al. 2021), while carbon tax is implemented in Singapore and Japan.

While addressing the issue of climate change, carbon pricing can play an important role in raising the revenue as well. The International Monetary Fund estimated that, in the Asia and the Pacific region, the additional revenue of carbon tax could reach to 0.8% of gross domestic product (GDP) in 2030 if the tax level is $25 per ton of carbon dioxide (CO_2) (Dabla-Norris et al. 2021) (Figure 26). Similarly, the same International Monetary Fund report estimated that, in the same region, the carbon tax revenue will become 1.9% of GDP in 2030 at the level of $75 per ton of CO_2. Thus, environmental policy instruments can deliver a decent amount of revenue for governments.

This paper discusses revenue-raising green policy instruments, providing a practical base for policymakers who are considering the introduction of carbon pricing or environmental tax/ETSs in their own countries. Section II introduces the concept of carbon pricing and illustrates how they are implemented in Asian countries. In section III, we will discuss the pollution issues together and environmental tax or fees and ETSs implemented in Asia. Section IV explains challenges and opportunities in implementing revenue-raising green policy instruments. Finally, we conclude the paper with policy implications.

II. CARBON PRICING

A. Carbon Tax

1. Concept of Carbon Tax

Carbon pricing is a policy instrument that mitigates the carbon emissions through economic incentives. By putting a price on carbon emissions, prices of products or services that emit CO_2 in their production processes increase. Consequently, consumers are expected to choose products/services that emit less emissions, thereby contributing to lower emissions from the economy.

One major advantage of carbon pricing is to lower the cost for abatement for the jurisdiction. The abatement of carbon dioxide emission entails cost. Through the usage of the market mechanism, carbon pricing can lower the total abatement cost for the jurisdiction that implements carbon pricing. Another advantage of carbon pricing as a climate change policy instrument is flexibility (Asian Development Bank [ADB] 2021b).

Broadly speaking, carbon pricing can be categorized into two types: carbon tax and ETSs. Carbon tax is one popular method of implementing carbon pricing. Typically, (regional or national) governments charge a uniform tax based on one ton of CO_2 emissions from economic activities. It is built upon a concept of Pigouvian tax that internalizes the negative externality of climate change into a market mechanism to maximize the social surplus. By putting a price on carbon, carbon tax reduces economic activities that emits CO_2.

Ideally, carbon tax should reflect the social (marginal) cost of carbon. In most cases, however, the level of carbon tax is lower than the social cost. Therefore, carbon tax internalizes the negative externality partially. Thus, it may not maximize the social welfare though it improves the welfare.

There are several ways to implement carbon tax. One popular way is to charge carbon tax at upstream. CO_2 emissions from the fossil fuel combustion depend on the carbon content of each fossil fuel type. Therefore, by imposing the tax on fossil fuel production at upstream, governments can collect carbon tax accurately and relatively easily. Products that require more carbon emissions will face the higher increase of the production cost because of the tax.

Another way of implementing carbon tax is to charge carbon tax at downstream. In this method, governments must determine the carbon content of the products or services, that is, the carbon emissions that were required to produce the products or services. The implementation of this downstream carbon tax is not easy because it can be quite complex and difficult to measure the carbon content of products because governments must grasp emissions at every stage of production all through their supply chains.

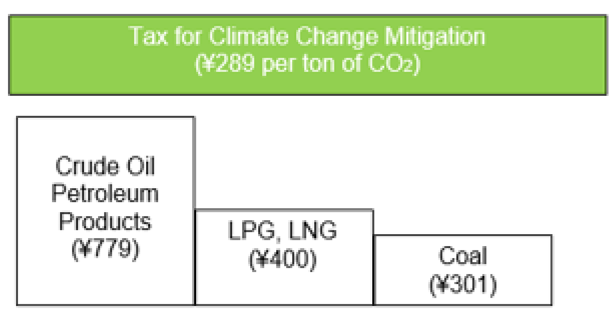
As we discuss the details in section IV.D, the impact of carbon tax on government revenue or emission are influenced whether the government earmarks the revenuer or not. If the tax revenue is earmarked for climate policy, the net increase of the general budget may be limited.

2. Japanese Experience

In 2012, the Government of Japan introduced carbon tax, known as “tax for climate change mitigation”. To ease the burden of households and firms, the tax initially started at a low rate and increased over 3.5 years. In 2012 when the tax rate was introduced, the rate was about ¥96 per ton of CO_2 (¥250 per kilo for oil). In 2014, the tax was raised to ¥192.7 per ton of CO_2 (¥500 per kilo for oil). In 2016, the tax was increased to the current level of ¥289 yen per ton of CO_2 emissions (¥760 per kilo for oil).

One unique feature of the Japanese carbon tax is that it is making use of the existing tax system of petroleum/coal tax. The petroleum/coal tax is charged on fossil fuels when they are imported to Japan or are exploited. Because Japan imports most of fossil fuels, the collection of the tax is relatively simple. The tax was originally intended to address the energy security issues when Japan faced the oil crisis in the 1970s. The carbon tax was added on top of the petroleum and coal tax. Therefore, the tax rate per ton of CO_2 emission is not equal among fossil fuel types. Figure 1 illustrates the structure of petroleum/coal tax and carbon tax. The heights show the tax level per ton of CO_2 by fuel type.

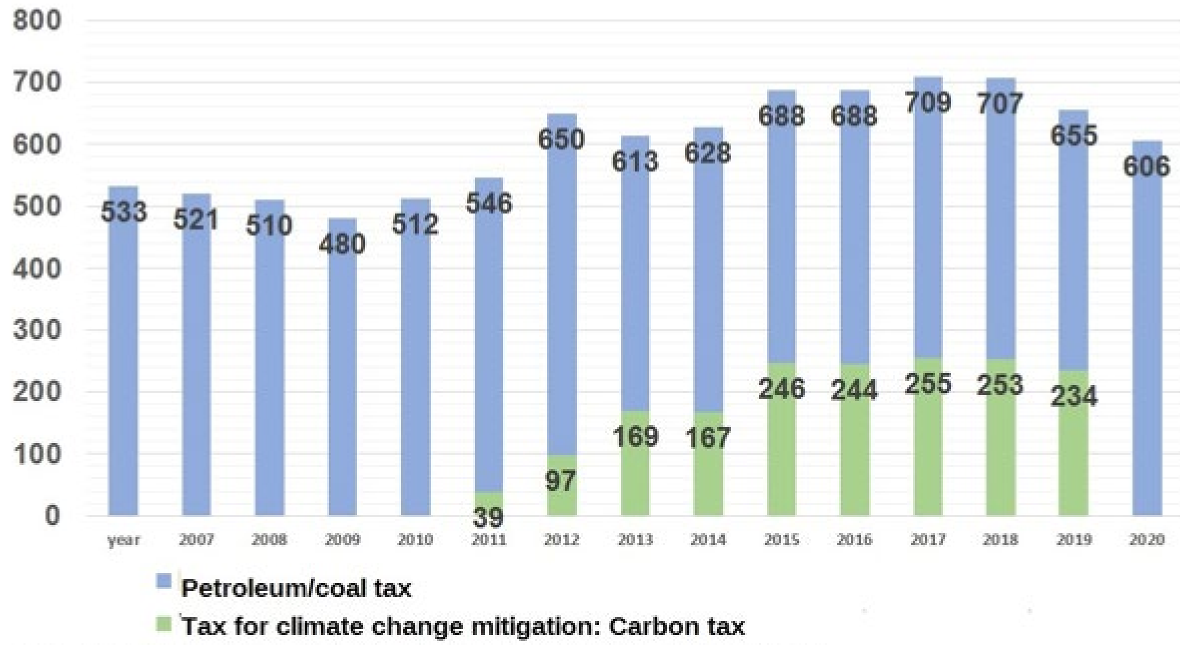
Figure 1: Carbon Tax in Japan:
Tax Rate per Ton of CO_2 Emissions by Fuel Type



CO_2 = carbon dioxide, LNP = liquefied natural gas, LPG = liquefied petroleum gas.
Source: Author’s construction based on Government of Japan, Ministry of Environment (2021).

The Ministry of the Environment (MOE), Government of Japan estimated the emission reduction because the price increase was at least 3.20 million tons of CO_2 in 2019 (MOE 2021). The size of the emission reduction is not so large because the tax level charged on fossil fuel amounted to be small. For example, it is equal to ¥0.76 (less than 1 cent) per litter of gasoline. Therefore, the emission reduction from the price increase because the carbon tax was expected to be limited. However, the Government of Japan has been using this tax revenue to promote renewable energy and energy efficiency, thereby contributing emission reduction. Out of the tax revenue, MOE used ¥160 billion to promote energy efficiency and renewable energy. Using the revenue, MOE provided subsidies when firms adopt low carbon technologies. MOE estimated the emission reduction from their spending to be 18.8 million tons if we sum the emission reduction from 2012 to 2018 (MOE 2021).

Figure 2 : Transition of the Revenue: Carbon Tax and Oil/Petroleum Tax (¥ billion)



Source: Government of Japan, Ministry of Environment (2021).

We can point out that the tax revenue from carbon tax changes over time as emission changes because of various factors, including regulations or the carbon tax itself. Figure 2 illustrates how the revenue from carbon tax has changed together with the revenue of the petroleum and coal tax. (Ministry of Finance, Government of Japan 2021). The tax revenue increased from 2012 to 2014 as the carbon tax rate was raised. At the peak, the revenue from the carbon tax reached to ¥255 billion in 2017. The tax revenue, together with petroleum/coal tax, seemed to have started decreasing because the Japanese economy successfully reduced emissions.

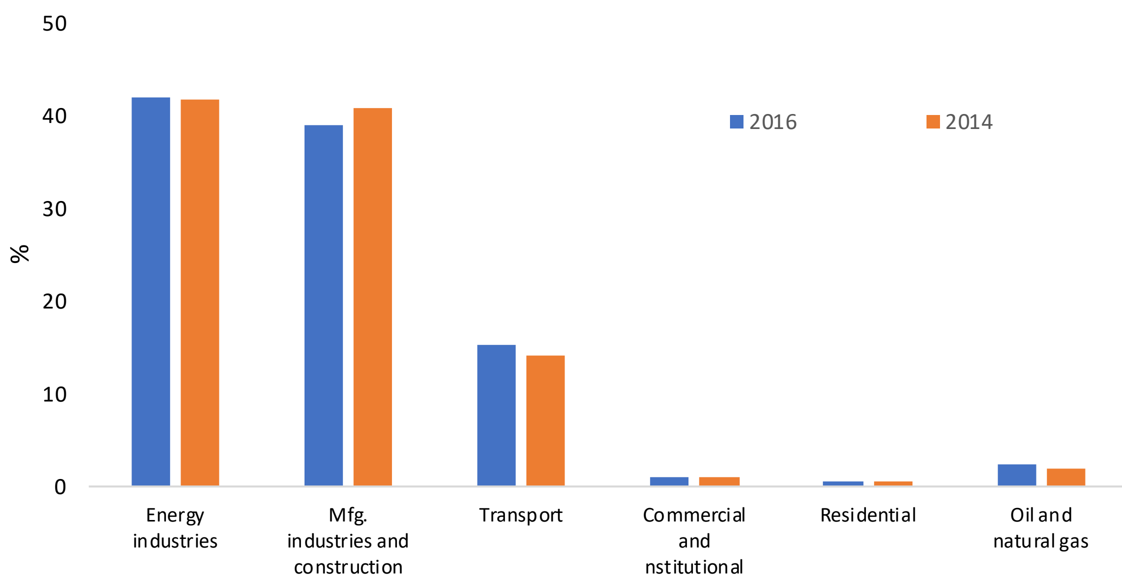
To ease the burden on some economic sectors, the Government of Japan has exempted energy-intensive sectors such as iron and steel or cement in their production process. Kerosene in agricultural and fishing industries are exempted as well. In addition, coal usage in the power sector of Okinawa Island is also exempted from the carbon tax because they do not have much option to reduce carbon emission at this stage, given the geographic characteristics.

3. Singapore

On 1 January 2019, Singapore introduced carbon tax to achieve its commitment under the Paris Agreement of reducing carbon emission intensity by 36% from its 2005 level by 2030 and achieve net-zero emissions in the second half of the century.

The tax was first applied in 2020 uniformly to facilities across all sectors with annual total direct emissions of at least 25,000 metric tons of carbon dioxide equivalent (tCO_2e) based on their 2019 annual emission levels. This measure helps targeting carbon tax to about 40 large direct emitters, which contribute to about 80% of Singapore's total GHG emissions. These heavy emitters are mainly petroleum refining, chemical and semiconductor companies. As shown in Figure 3, top emitters are largely from the energy, manufacturing, and construction industries as of 2016.

Figure 3: Share of Emission in Total Emissions by Sector (2016 versus 2014)



Source: Singapore National Climate Change Secretariat. 2020. *Fourth Biennial Update*. https://www.nccs.gov.sg/media/publications/singapores-national-communications-an-biennial-update-reports (accessed 10 September 2021).

To allow businesses time to prepare, gradually lower emissions, and mitigate possible adverse impact on economic activities, the carbon tax rate is initially set at S$5/$tCO_2e$ during the period 2019–2023, then adjusted to S$10/$tCO_2e$ –S$15/$tCO_2e$ in 2023 after an impact assessment in 2022. In February 2021, the government announced it will review its post-2023 trajectory and level of carbon tax, the details of which will be announced during the budget hearing in February 2022. For households, the government provided an annual $20 utilities-save to qualified household to offset possible price impact of carbon tax.

The government initially estimated to collect a carbon tax revenue of about $1 billion during the first 5 years. In 2020, the total carbon tax collected were $144 million, which accounts for about 0.4% of total

tax revenue of S$49.6 billion ($36.8 billion).[1] In July 2021, the minister for sustainability and the environment stressed that the current rate at S$5/t$CO_2$e may not be sufficient to curb emissions, signaling that the government may fasten the tax rate adjustment to meet its commitments to tackling climate change (Tan 2021 and Xu 2021).

To support the transition towards a low-carbon economy, Singapore introduced various schemes, such as the Productivity Grant, the Energy Efficiency Fund, and the Energy Efficiency Financing Program, to help business improve energy efficiency and reduce emission. Singapore also encouraged generation of clean energy. On 14 July 2021, Singapore opened one of the world's largest inland floating solar photovoltaic systems—about the size of 45 football fields—at Tengeh Reservoir to boost its solar energy capacity.

4. Indian Coal Tax

India does not have an explicit carbon tax system but the imposition of a cess[2] in coal items based on 'polluter pays' principle, mimics that of a carbon tax (PIB 2010). In 2010, the Government of India had introduced the Clean Environment Cess to be imposed as excise duty on the use of coal items under the Finance Act 2010 with a dual objective: (i) dissuade the production and consumption of coal by increasing the cost, and (ii) generate revenues to the National Clean Energy Fund to support clean energy initiative and renewable energy development (IISD 2017 and Chandra 2021). The cess was initially implemented at a rate of ₹50 (US$0.68) per ton in fiscal year (FY) 2010 but later increased by eightfold to ₹400 per ton (US$5.46) in FY 2017 (IISD 2020). Panel I of Figure 4 presents the change in coal cess over the period FY 2010–FY2017 while panel II presents the revenue generated over the years.

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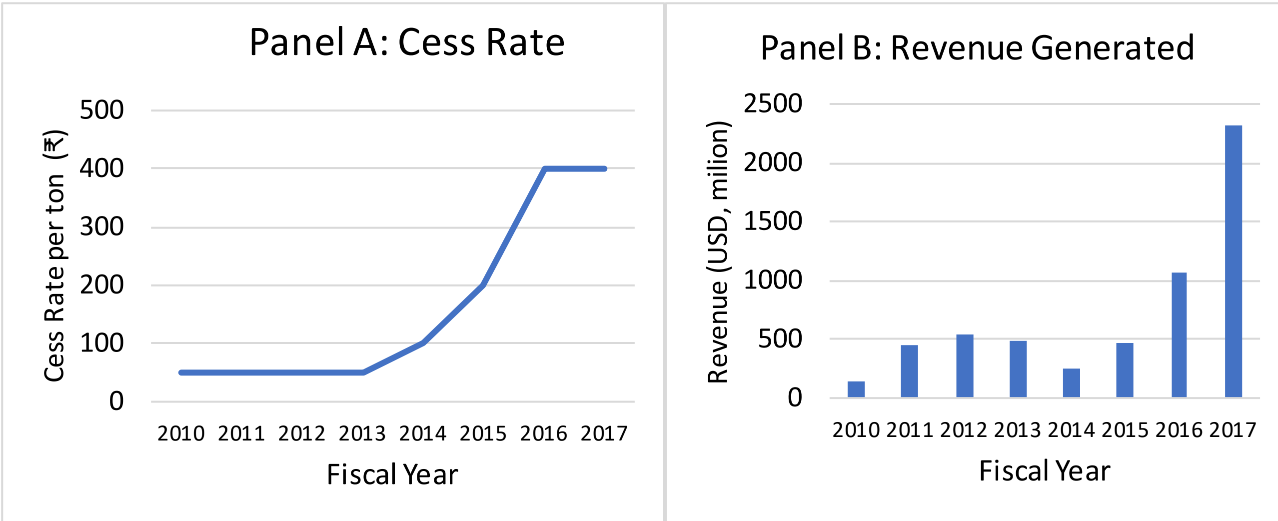
1 Source: Carbon tax revenue is from https://www.statista.com/statistics/1241742/carbon-tax-revenues-worldwide-by-selected-country/. The amount of carbon tax collection was S$197.6 million ($147.3 million) according to Haver. The total tax revenue is from https://data.gov.sg/dataset/iras-collection-by-tax-type-annual.

2 Cess can be defined as a specific form of tax levied by the government over the base tax liability of the taxpayer, for revenue generation for any specific purposes.

Figure 4: Change in Clean Environment Cess Rates and Revenues During FY2010- FY2017



Source: IISD (2017, 2020) and Chandra (2021)

Although this scheme appeared to be promising, it failed to deliver the desired outcomes as a substantial amount of the revenue remained unutilized. For example, during FY2010–FY2017, the revenue generated from this cess amounts to US$11,813.94 million of which only US$4,052.91 million have been transferred to the National Clean Energy Fund and US$2,174.59 million utilized (Chandra 2021).

With the advent of the goods and services tax (GST) in 2017, the Clean Environment Cess was replaced by the GST Compensation Cess under the Taxation Laws Amendment Act 2017, but the rate was kept the same at ₹400 per ton (IISD 2018). This GST compensation cess is expected to compensate the budget deficits that the Indian states have faced following the introduction of GST (Chandra 2021).

5. Association of Southeast Asian Nations Cases

As of October 2021, among all the Association of Southeast Asian Nations (ASEAN) member countries, only Singapore has carbon tax as described in section I.A.3. Indonesia will start to implement carbon tax in April 2022 while they are preparing for ETS of CO_2Most of the member countries are imposing excise tax on petroleum for petroleum products except Cambodia, Myanmar, and Brunei Darussalam. For instance, the Philippines imposes ₱6 per liter and Thailand B6.44 per liter. There is a lot to leverage based on the experiences of imposing energy tax when introducing carbon tax in ASEAN member countries.

6. Summary of Non-Asia Experience

In recent years, many countries have introduced carbon tax to reduce GHG emission since the first carbon tax in Finland. Carbon tax implemented across the globe also differs in many aspects including sectors covered, fuels covered, tax rate, fuels and sectors exemptions, coverage (% of emission covered), revenue recycling policy and method of determining the tax rate. For instance, Mexico carbon tax rate is capped at 3% of the fuel price. Similarly, in Canada, the province of British Columbia considered its carbon tax to be revenue neutral (as tax revenue is ploughed back to economy in the form of tax credits and reduced income tax). This policy is expected to incentivize innovations in identifying the cost-efficient methods of reducing emissions. However, in majority of countries, shipping and aviation are exempted. On the other hand, in some cases, revenue recycling policies are not evident. However, current experiences of introducing carbon tax show that governments are able to generate revenue through carbon tax. Revenues from carbon tax and cap and trade programs may provide revenues in developing Asian countries for financing sustainable development programs. Table 1 summarizes these experiences of carbon pricing in non-Asian regions.

Table 1: Carbon Tax Rate and Revenue by Country

Sl#	Country	Year	Emission Covered (%)	Fuels Covered	Exempted Sectors/Fuel	Tax Rate (price $)	Revenue (US$ million)
1	Argentina	2018	20	Liquid fuels and coal	Yes	6	0.5
2	Mexico	2014	23	All fuels except gas	NA	3	230
3	British Columbia (Canada)	2008	78	All fuels and tires combusted	Yes	36	1,266
4	United Kingdom	2013	23	All fossil fuels	Yes	25	948
5	Sweden	1991	40	All fossil fuels	Yes	137	2,284
6	Finland	1990	36	All fossil fuels	Yes	Transport: 72.8 and others: 62.3	1,420
7	France	2014	35	All fossil fuels	Yes	52	9,632
8	Estonia	2000	6	All fossil fuels		2	2
9	Slovenia	1996	50	All fossil fuels	Yes	20	81
10	South Africa	2019	80	NA	Yes	9	43.3
11	Chile	2017	39	All fossil fuels	NA	5	165
12	Columbia	2017	24	Liquid and gaseous fossil fuels	NA	5	29

NA = Not Applicable _____, US = United States.

Note: "Year" refers to year when carbon tax was first introduced and "Emission Covered (%)" refers to percent of emission covered from the total emission within the jurisdiction. Tax rate is US$/t$CO_2$e. Tax rate and tax revenue are for the year 2021 and 2020 respectively. NA indicates information is not available or not applicable.

The governments of developing countries may be concerned whether carbon tax can be a potential source of revenue. The experience of introducing carbon tax in developing countries, such as South Africa, Chile, and Columbia, suggests that developing countries can generate green revenues. For instance, as reported in the Table 1, Chile generated a total revenue of US$165 million and Columbia generated US$29 million. Moreover, in both countries, carbon tax covers about 39% and 24% respectively of total emissions which suggest that carbon tax may help in achieving emission reduction as well generation of revenue.

B. Emissions Trading Schemes

1. Concept of Emissions Trading Schemes

Another type of carbon pricing is emissions trading scheme (ETS). In this scheme, governments set the total amount of emissions (Cap) allowed from the target facilities in the jurisdiction. Governments issue the permits of emissions whose sum is equal to the emission target of the jurisdiction. Owner of the regulated facilities must hold emission permits equal to their emission. If they have extra permits after they reduce emissions, they can sell such extra permits. Alternatively, they can purchase permits if they need more. Therefore, it is often called "Cap and Trade Scheme". In contrast to carbon tax, ETS can reduce the emissions with certainty.

There are several ways how governments can issue emission permits. First, they can allocate permits freely to facilities. It is called grandfathering if permits are based on the historical emissions. In other cases, permits are given based on the benchmark of technologies. Another way of issuing permits is auction. In this case, emitters of CO_2 must purchase permits from the government. This way, governments can raise revenue with ETS. As depicted below, many ETSs started from free allowance and shifted to an auction system as the system became more mature.

One should mention that the coverage of ETS tends to be smaller than carbon tax. ETS tends to focus industries and less likely to cover transport, at least at its early stage. Moreover, no ETS has covered households. In addition, to avoid administrative burden, ETS tends to focus on larger emitters while carbon tax can cover smaller emitters or households relatively easily. Measuring emissions at small and medium-sized enterprises (SMEs) may require a large amount of government resources while carbon tax can cover SMEs if the government charge carbon tax at upstream.

The Kyoto Protocol was the first international agreement that adopted ETS. The Kyoto Protocol allowed countries to use ETS to achieve their emission targets. Countries were allowed to acquire allowances from countries with the emission-reduction targets. Alternatively, developed countries with the reduction obligation were able to obtain emission-reduction credits through Clean Development Mechanism (CDM) (ADB 2021b).

2. Korean Emissions Trading Scheme

To meet the country's 2030 updated Intended Nationally Determined Contribution target of a 24.4% reduction from 2017 emissions, the ROK launched its nationwide mandatory ETS on 1 January 2015. It was implemented through the Act on Allocation and Trading of Greenhouse Gas Emissions Allowances (Emissions Trading Act) enacted in November 2012. The Korea Emissions Trading Scheme (KETS) is

implemented in three phases, with 2015–2017 as Phase 1, 2018–2020 as Phase 2, and 2021–2024 as Phase 3. During implementation, adjustments have been made over different phases.

The scope of the KETS has been expanding during the implementation. In Phase 1, the annual cap for GHG emissions was initially set to 1,686.3 $MtCO_2e$. The KETS covers 23 subsectors from five sectors being power, industry, buildings, waste, and transport (domestic aviation) (International Carbon Action Partnership [ICAP] 2021).[3] In Phase 2, the cap was increased to a total 1,777 $MtCO_2e$, and coverage of emissions cap was adjusted to 62 subsectors from six sectors being heat and power, industry, buildings, transport, waste sector, and the public sector. In Phase 3, the cap was increased to 3,048.3 $MtCO_2e$ and the emissions cap coverage was expanded to 69 subsectors as more transport subsectors such as freight, rail, passenger, and shipping are included. The number of participating companies thus increased from about 534 in Phase 1 to 685 by the start of Phase 3, accounting for 73.5% of national GHG emissions as of 2020. All companies in the covered subsectors with average annual direct GHG emissions equal or greater than 125,000 tCO_2e over 3 consecutive years, or facilities with annual average annual GHG emissions equal or greater than 25,000 tCO_2e over 3 consecutive years are mandated to participate. (Hyun and Oh 2015 and ICAP 2021). At the end of each reporting year, participants need to report emission details from all covered emission sources. Noncompliance will result in a penalty not exceeding three times the average market price of the reporting year or W100,000 per ton.

To ensure smooth implementation and allow time for businesses to adjust, the KETS adopted a gradual approach in emission allowance allocation, shifting from free allocation to auction. In Phase 1, the allowances were allocated for free to all covered entities based their average GHG emissions during the base period of 2011–2013. The power generation sector got the highest allocation of about 46% of total allowance allocation, followed by energy-intensive industries. In Phase 2, 3% of total allocation were subject to auctioning with participants from 26 eligible subsectors. After the first allowance auction in 2018, regular monthly auctions started in 2019 and are open to all covered entities except those receiving full free allowances. This share of auctioning emission allowances was increased to at least 10% in Phase 3, allowing 41 out of the 69 subsectors to participate, while the remaining 28 subsectors still receiving full free allocations (Table 2). Since the beginning of the program, the total revenue generated by the KETS recorded W480.7 billion (US$407.3 million) as of August 2021, of which W248.3 billion (US$210.4 million) was collected in 2020 alone (ICAP 2021). The government has proposed possible options for revenue usage, such as supporting mitigation equipment, low-carbon innovation, and technology development of covered entities. (IETA 2020 and ICAP 2021)

Table 2: Allowance Allocation of the Republic of Korea Emissions Trading Scheme, by Phases

Allocation	Phase 1 (2015–2017)	Phase 2 (2018–2020)	Phase 3 (2021–2025)
Free allocation	100% free allocation Most sectors received free allowances based on the average	97% of allowances distributed for free Toward the end of phase 2, the share of sector-specific benchmarking reached 50% of total	Less than 90% of allowances distributed for free The share of sector-specific benchmarking is to reach 60%, covering 12 sectors.

[3] ICAP. 2021. *Korea Emissions Trading Scheme*. https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=47.

Allocation	Phase 1 (2015–2017)	Phase 2 (2018–2020)	Phase 3 (2021–2025)
	greenhouse gas emissions of the base years (2011–2013).	primary allocation, covering seven sectors.	100% free allocation: (i) EITE sectors; and (ii) all local government units, schools, medical institutions, and public transport operators.
Auctioning	None	3% of allowances are subject for auctioning Regular auctions began in 2019 (7.95 million allowances in 2019 and 9.3 million allowances in 2020). Companies that do not receive full free allowances are eligible to bid. Single bidder cannot purchase more than 30% of the allowances of any auction.	At least 10% of allowance is subject to auctioning. Entities from 41 subsectors, (excluding EITE sectors) can participate in auctions. The same auction provisions as for phase 2 apply.

EITE = energy-intensive and trade-exposed.

Sources: Asian Development Bank. 2018, International Emissions Trading Association 2020, and International Carbon Action Partnership 2021.

3. Emissions Trading Schemes in the People's Republic of China

During its 12th five-year plan period (2011–2015), the People's Republic of China (PRC) launched seven pilot ETSs in five cities (Beijing, Shanghai, Tianjin, Chongqing, and Shenzhen) and two provinces (Guangdong and Hubei) which started operation in 2013 and 2014. In 2016, the eighth pilot ETS was launched in Fujian province. Each pilot ETS has its own design conditional on local circumstances and economic profile. Thus, these ETSs differ in scope; financial products; benchmarks and allowance allocations; monitoring, reporting, and verification (MRV) methods; and market prices. The eight pilot ETSs adopted different market design options and market practices that are tailored to local features in achieving their respective emission targets. According to data from the Ministry of Ecology and Environment, the eight pilot ESTs distributed 406 million tons carbon emission trading allowance by August 2020, making the world's second-largest market (ADB 2020). Table 3 reports revenues generated by the pilot ETSs since their establishment. As shown, revenues generated vary significantly across different market models. These pilots provided lessons and experience for the development of the national ETS.

Table 3: Revenue Generated by Pilot Emissions Trading Schemes

City/Province	Date of Launch	Total Revenue from Establishment to 2020 (CNY million)
Guangdong	December 2013	815.5
Shenzhen	June 2013	2.6
Tianjin	December 2013	349.7

City/Province	Date of Launch	Total Revenue from Establishment to 2020 (CNY million)
Shanghai	November 2013	102.2
Beijing	November 2013	
Chongqing	June 2014	
Hubei	April 2014	212
Fuijian	September 2016	

Sources: International Carbon Action Partnership (2021), various reports, https://icapcarbonaction.com/en/.

The PRC launched an initial framework of its national ETS in December 2017. After years of refinement and preparation, the Ministry of Ecological Environment issued "the Measures for the Management of Carbon Emissions Trading (Trial)", "Implementation Plan for the Setting and Assigning of the Total Quota for the National Carbon Emissions Trading (Power Generation Industry) for 2019–2020", and "The List of Key Emission Entities (including power generation enterprises and self-owned power plants) in December 2020 and "Interim Regulations for the Management of Carbon Emissions" in March 2021, which supports the formal operation and implementation cycle of the national ETS in July 2021 (ICAP 2021). While the pilot ETSs continue to operate in parallel with the national ETS, they will be gradually integrated into the national ETS (China Carbon Forum 2018 and ICAP 2021).

The PRC's national ETS covers 2,225 participants from the power sector with emission more than 26,000 tCO^2 per year. Participating companies are mostly state-owned enterprises with some being previously covered by pilot ETSs and now transitioning into the national market. They are estimated to account for about 40% of the PRC's energy-related emissions (ADB 2021). The ETS focuses on CO_2 emission intensity, which will incentivize emitters to lower emission per unit energy generation but may not necessarily reduce absolute emissions.

The emitters will be allocated a certain number of emissions allowances for free during the initial implementation phase, based on their verified site output and "benchmarks" of emissions per unit of output, as well as other adjustments. The cap is based on emissions intensity according to the actual production following a bottom–up approach, which means the sum of cap equals the total allowance allocation to all covered entities, currently estimated at 4,000 $MtCO_2$/year for 2021. Unconventional coal-fired power plants that burn coal wastes or a mix of coal and biofuel are given 30% more allowances than large conventional coal plants and 192% more than gas-fired power plants. These allocations are still subject to possible adjustments. While auctioning is not yet implemented, it may be introduced later.

On 16 July 2021, carbon allowances opened at CNY48 ($7.42) a metric ton, traded as high as CNY52.80, and closed at CNY 51.23 a metric ton, with a trading volume of 4.1 million tons (Bloomberg 2021). One of the world's top coal producers, China Petroleum & Chemical Corp participated, signaling the sector's commitment to reduce emissions. As of 11 August, the cumulative trading volume reached 6,647,831 tons with a trading value of CNY326,520,466, averaging CNY49.1 per ton.

The PRC's national ETS is still at its initial stage with some challenges to be further addressed during the implementation of the ETS. One challenge is the limited scope in terms of sector coverage and market players. Broadening market scope and developing measures to boost trading. Another challenge is the smooth integration of pilot ETS in the national ETS, given the various designs of pilot ETSs. The third challenge is to ensure quality emission data for effective market functioning. This calls for integrity

of reporting and monitoring of emissions. Under the assumption that ETS will gradually tighten benchmarks over time, International Energy Agency (IEA) (2021b) finds that compared to a no-ETS scenario, the national ETS would be able to “cost-effectively make power sector CO_2 emissions peak before 2030”.

4. Tokyo and Saitama Emissions Trading Schemes in Japan

Japan has not implemented a nationwide ETS until now. However, the Tokyo metropolitan government has implemented the first cap and trade of CO_2 in Asia since 2010 (Arimura and Abe 2021). Saitama prefecture, a neighboring state of Tokyo, started its own ETS (Hamamoto 2021b in 2011. The emission target become more stringent as phase goes further in both ETSs (Table 4). Both Tokyo and Saitama ETSs have adopted grandfathering to allocate permits and have conducted no auction up to now. Therefore, there is no revenue generated from the two regional ETSs in Japan.

These two reginal markets are unique in several aspects. Tokyo ETS was the first ETS that covers office buildings. The previous ETSs in the European Union (EU) or North America targeted manufacturing sectors and power plants until then. Saitama is also unique because there is no penalty for violation (Table 4). However, because of close communication between the prefectural government and business sectors in Saitama, most of facilities have complied with the ETS.

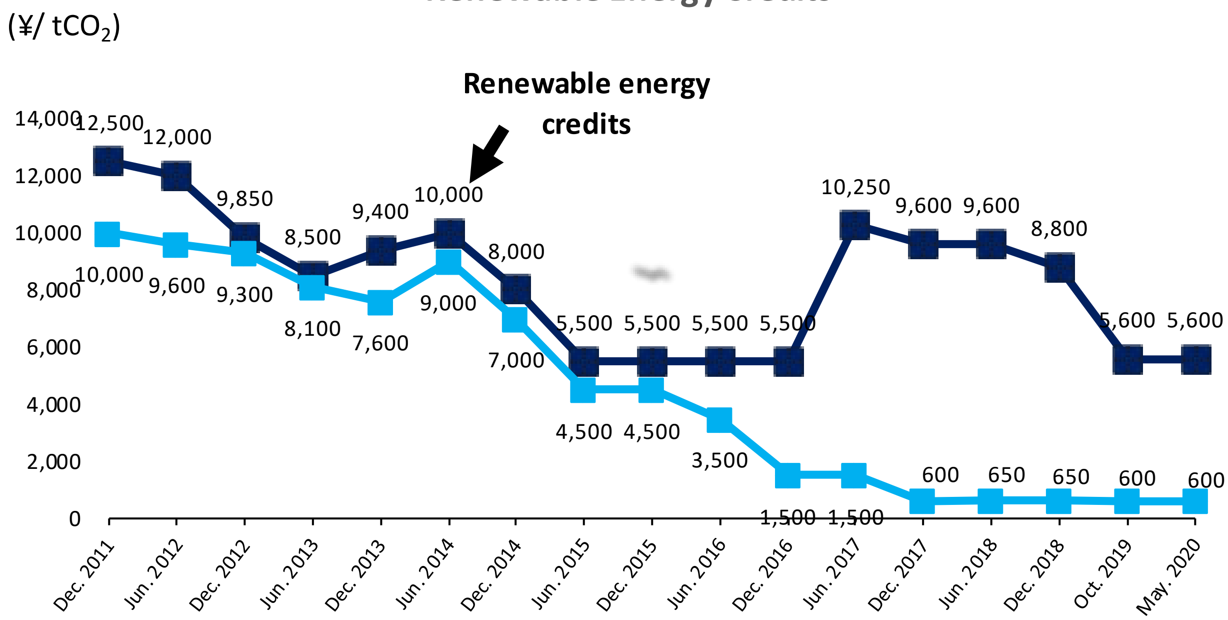
Table 4: Basic Features of Tokyo and Saitama Emissions Trading Schemes

<table>
<tr><th colspan="2"></th><th colspan="2">Tokyo</th><th colspan="2">Saitama</th></tr>
<tr><td rowspan="3">Compliance period</td><td>1st period</td><td colspan="2">FY2010–FY2014</td><td colspan="2">FY2011–FY2014</td></tr>
<tr><td>2nd period</td><td colspan="2">FY2015–FY2019</td><td colspan="2">FY2015–FY2019</td></tr>
<tr><td>3rd period</td><td colspan="2">FY2020–FY2024</td><td colspan="2">FY2020–FY2024</td></tr>
<tr><td rowspan="5">Reduction target</td><td></td><td>Office Buildings</td><td>Factories</td><td>Office Buildings</td><td>Factories</td></tr>
<tr><td>1st period</td><td>8%</td><td>6%</td><td>8%</td><td>6%</td></tr>
<tr><td>2nd period</td><td>17%</td><td>15%</td><td>15%</td><td>13%</td></tr>
<tr><td>3rd period</td><td>27%</td><td>25%</td><td>22%</td><td>20%</td></tr>
<tr><td></td><td colspan="2">Medium- to small-sized businesses are excluded from compliance.</td><td colspan="2">Medium- to small-sized businesses are NOT excluded from compliance.</td></tr>
<tr><td colspan="2" rowspan="2">Base-year emissions</td><td colspan="4">Calculated based on the average of emissions of selected 3 consecutive fiscal years between FY2002 and FY2007.</td></tr>
<tr><td colspan="4">*Newly covered facilities can also choose method based on emission intensity standards.</td></tr>
<tr><td colspan="2">Enforcement</td><td colspan="2">Order to reduce shortage of obligation X 1.3 times. ⇒ Fines, disclosure of violation when violating an order</td><td colspan="2">No penalty</td></tr>
</table>

Source: The Authors' construction based on Arimura and Matsumoto (2021).

There is no market makers and no price-revealing mechanism in the Japan regional ETS. There is no auction of permits or public market. Financial intermediaries cannot enter the market. This was intentionally designed to respond to "money game" criticism by the Japanese Business Federation (Roppongi et al.2017). Accordingly, all the trades have been bilateral, and the price has not been revealed for each transaction. However, Tokyo Metropolitan Government conducts a survey on the transactions and published the average price of permits (Figure 5). It should be noted that liquidity is a challenge in Tokyo ETS as in many markets in the ROK or some Chinese pilot markets.

Figure 5 : Change in Prices of Excess Emission Reductions and Renewable Energy Credits



Source: Based on Tokyo Metropolitan Government Information

These two regional ETSs successfully reduced emissions. The emission from the target facilities in Tokyo ETS declined by 27% from the baseline in 2019. The emission from the Saitama ETS facilities reduced by 22% compared to the baseline during Phase I from 2011 to 2014. Some have argued that these reduction from other factors such as the rise of the electricity price or the shock of the Great East Earthquake of Japan in 2011. Using a facility level data, Arimura and Abe (2021) found that Tokyo ETS was contributing more than half of the emission reduction in the office buildings during the first 4 years. Hamamoto (2021a) found Saitama ETS promoted the adoption of low-carbon technologies. Thus, the two regional ETS were effective in the emission reduction.

5. Kazakhstan Emissions Trading Scheme[4]

The pilot phase of Kazakhstan ETS (KZ ETS) started in January 2013 after the amendments of environmental legislations in 2011 which was also the first phase of KZ ETS. The second phase of the implementation was in 2014–2015. Both phases one and two covered power sector and centralized heating, oil and gas mining, metallurgy, and chemical industry. However, in 2016–2017, KZ ETS was suspended to reform the allocation system. The third phase in 2018–2020 covered processing industry such as cement, lime, gypsum, and brick (in addition to sectors covered in the previous two phases). Currently KZ ETS is in the fourth phase. All the facilities that emit more than 20,000 tCO2e/year are covered. The Nationally Determined Contribution of Kazakhstan aims at reduction of 15% (unconditional) to 25% (conditional) of GHG from 1990 GHG level. By 2050, it targets to reduce 40% of CO2 emission from the power sectors from 2012 levels. Currently, KZ ETS covers 225 installations or facilities that are operated by 130 companies. Table 5 presents the overall features of KZ ETS.

Table 5: Features of Kazakhstan Emissions Trading Scheme

	Year	Allocation	Emission Cap
Phase 1	2013	Grandparenting	147 $MtCO_2$
Phase 2	2014–2015	Grandparenting	2014: 154.9 $MtCO_2$ 2015: 152.8 $MtCO_2$
Phase 3	2018–2020	Grandparenting or bench marking	485.9 $MtCO_2$ (cap for 2018, 2019, and 2020)
Phase 4	2021	Bench marking	159.9 $MtCO_2$

$MtCO_2$ = metric ton of carbon dioxide.
Source(s): {Please provide source(s) here.}

The KZ ETS covers only carbon dioxide only and the average carbon price was US$1.10/$tCO_2e$. Further in KZ ETS system, banking is allowed within each trading period. However, trading between trading periods is not allowed. Sector covered by ETS are required, i.e., those facilities emitting more than 20,000 tCO_2e/year are required to report annually. Further, KZ ETS also requires operators to report if the emission is above 10,000 tCO_2e/year although such operators are not required to participate KZ ETS. There is also penalty for noncompliance. In 2013 and 2014, the penalties for noncompliance were waived. However, in 2012, noncompliance penalty for each ton was about US$35.32 (or about T14,585).

6. Association of Southeast Asian Nations Cases

Among ASEAN member countries, the Government of Thailand is currently piloting ETS voluntarily, and it is initially known as Thailand Voluntary Emissions Trading System (V-ETS). Two phases of V-ETS have been completed so far. The first phase was held from 2015 to 2017 and mainly focused at testing of MRV and allowance allocation system. During the first phase, MRV and allocation systems were tested on four carbon-intensive sectors; namely, cement, pulp and paper, petrochemical, and iron and steel. During the second phase, which was held from 2018 to 2020, it included five additional sectors; namely, ceramics, plastics, glass, food and feed, and petroleum. During the second phase, it was tested for registry and trading platform in addition to MRV. Currently, there is a plan to further pilot the implement of ETS in Thailand by including important components of ETS. Further, in Viet Nam and Indonesia, the introduction

[4] All information obtained from https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5b%5d=46.

of ETS is under consideration. However, no pilot programs have been implemented so far. Recently, Indonesia and Viet Nam are discussing the introduction of ETS.[5]

7. Summary of Non-Asia Experience

Cap and trade program in Europe and the United States had evolved over time in many aspects, including the initial allowance allotment, sector and fuel covered, and revenue usage.

The European Union Emissions Trading Scheme (EU ETS) is the first Cap &Trade Program of CO_2 in the world and the largest as of 2021. It started from grand fathering in its pilot phases in 2005 and moved to auction for the power sector in Phase II (2008–2012). Since then, EU ETS has been expanding the target sectors of the auction.

In the United States, Regional Greenhouse Gas Initiative (RGGI) used auction system from the outset in 2009. Their target is the power sector and, hence, faced no international leakage issue. Thus, politically, it was easy to start the auction. The revenue from the auction have been used to promote renewable energy and energy efficiency.

California ETS (CaT), which started in 2013, also have been using an auction system. The price of permits in California ETS has been relatively stable compared to other ETSs and the price of the permits have increasing steadily.

The coverage of emissions differs across ETSs. According to the World Bank, EU ETS covers about 4% of global emissions while CaT and RGGI covers less than 1% of total global emissions (footnote 5).

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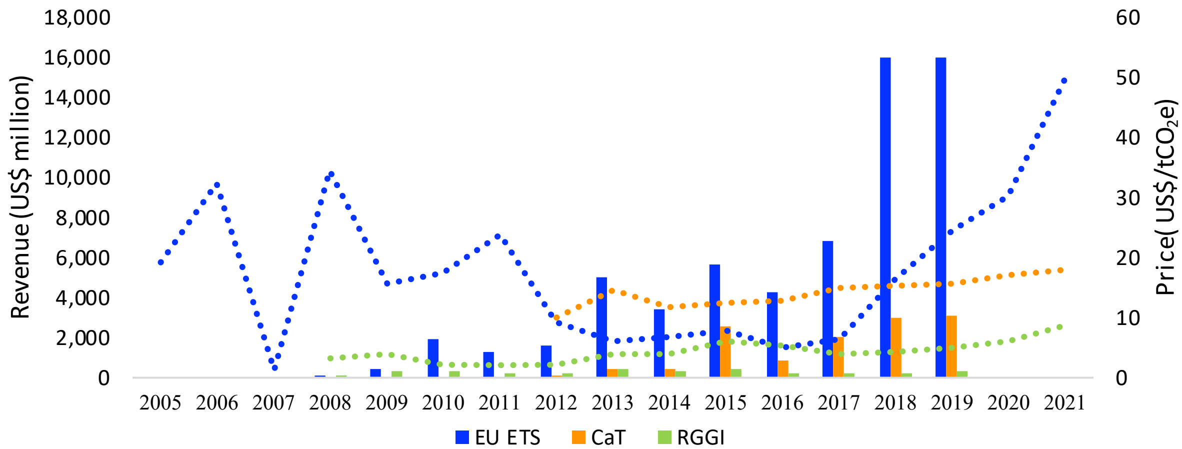
[5] https://carbonpricingdashboard.worldbank.org/map_data.

Figure 6: Emissions Trading System Revenue and Prices in Emissions Trading Schemes Among Non-Asian Countries



EU ETS= European Union Emissions Trading Scheme, CaT = California Emissions Trading Scheme, RGGI = regional greenhouse gas initiative.

Note: ETS revenue (bar) and price (line)

Source: https://carbonpricingdashboard.worldbank.org/map_data.

EU ETS initially covered about 50% of emissions in 2005 and is covering about 39% of total emission within the European Union jurisdiction. Because ETS reduced the emission from the target sector, the coverage of EUETS declined as time went by. RGGI covers about 23% of emissions within the jurisdiction while CaT covers about 80% total emissions.

These ETS generates revenue through auction. EU ETS generates a total revenue of about $16,011 million in 2019 and, similarly, RGGI generated about $416 million and CaT about $1,698 million. Figure 6 shows changes in the revenue and the permit pieces from the various ETSs.

The stability of permit price has been one important policy issue in ETSs. Facing the financial crisis from 2007 to 2008, the demand of permits sharply decreased and the prices fell in EU ETS and RGGI. In the case of RGGI, the regulation of the price floor was adopted and worked effectively in the auction. In EU ETS, the price of permits dropped after 2008 and had been low through 2010s. The low permit was criticized because it will not generate incentives to investment low carbon18 emission technologies. So, in 2019, the European Union decided to use “market stability reserve” mechanism to reduce the supply of permits and successfully increased the permit price.

C. Carbon Boarder Adjustment Mechanism

The recent proposal by European Union provides another way of collecting revenue for governments while they can address the issue of carbon leakage. To many countries, the introduction of carbon pricing entails objection from energy-intensive industrial sectors, such as iron and steel or cement, because these industries face the competitiveness issue and the risk of carbon leakage. Firms facing carbon

pricing may lose competitiveness against firms in countries without comparable climate policies. If so, production activities may move from countries with climate regulation to those without such policies, thereby increasing emissions in regions without such regulations. In this case, efforts of carbon mitigation in the regulated jurisdiction may be offset by the increase of the emissions overseas. It is called carbon leakage.

To address the issues of carbon leakage, many countries have discussed the possibility of carbon tariff, i.e., imposing tariff on the imports at the border based on the carbon content of the products. It was first discussed in the European Union when the United States left the Kyoto Protocol. Then, the United States Congress discussed the possibility when the Obama administration was discussing a cap-and-trade scheme at the federal level (Kyo et al. 2009). Japan also discussed the possibility and World Trade Organization compatibility of carbon tariff in 2010 under the Ministry of Finance. A simulation of Carbon Border Adjustment Mechanism (CBAM) for the Japanese economy was done (Takeda et al. 2012).

None of the discussions above have been specific and detailed until the European Union proposed CBAM in July of 2021. The European Union has proposed the use of an EU ETS scheme, instead of carbon tariff. Importers of the European Union must obtain emission certificates equivalent to the carbon content of the imported products. The price of certificates is determined by the price of EU ETS. Thus, the CBAM can be viewed as an extension of EU ETS. In this proposal, the European Union targets the following energy-intensive sectors: iron and steel, aluminum, cement, fertilizer, and electricity. The CBAM targets only the direct emissions, CO_2 emissions from fossil fuel combustion, and ignores the indirect emissions from the usage of the electricity.

This scheme is expected to generate a revenue for European Union member countries. The most revenue goes to the European Union budget. It is estimated to be €2.1 billion (European Commission 2021).

We should point out that CBAM is somewhat controversial because it may be considered as “protectionism”. The compatibility with World Trade Organization rules have been examined (Mehling et al. 2019).

III. ENVIRONMENTAL AND POLLUTION TAX

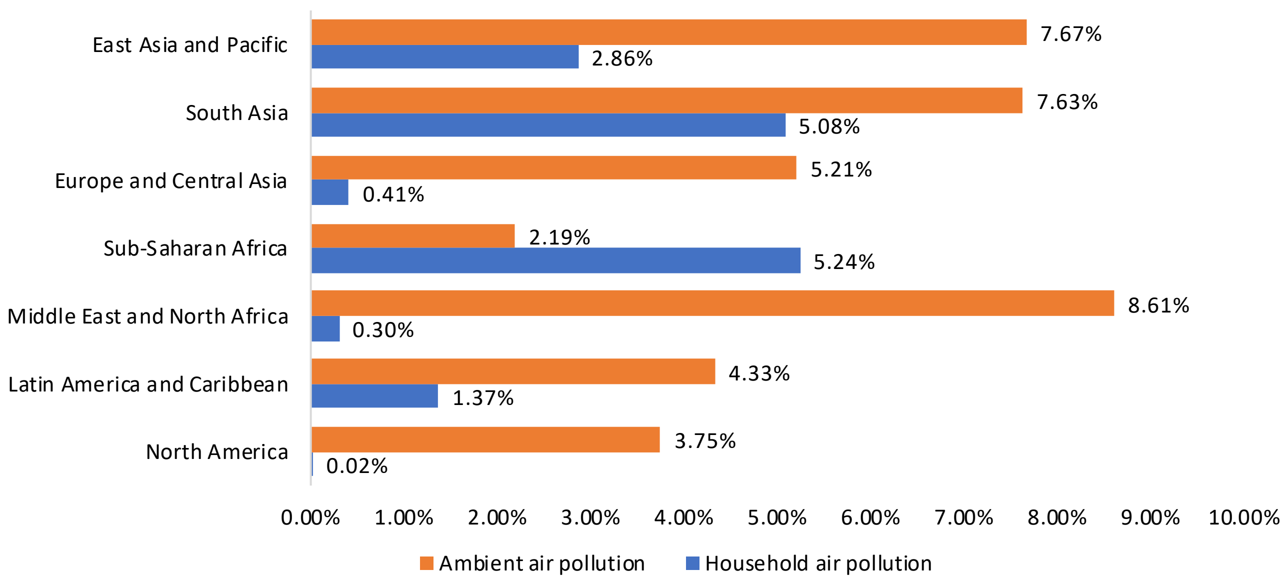
A. Air Pollution Issues in Asia

Many Asian countries are facing severe pollution problems. First, air pollution is a salient environmental and health risks in Asia. It is responsible for about 4 million annual premature deaths in Asia, and fine particulate matter ($PM_{2.5}$) is considered the greatest threat to human health (United Nations Environment Programme 2018 and ADB 2021a). Air pollutions can be broadly classified into two categories: ambient or outdoor air pollution and household air pollution. Ambient air pollution is mainly caused by the emissions from industries (26%), power generation (16%), and vehicular emissions (50%). For example, In the PRC, coal-burning for industry is the largest contributor to air pollution and made up 40% of $PM_{2.5}$ concentrations in 2013 (ADB 2021a). Heavy reliance on coal and biomass to meet the energy demand is another important cause of ambient air pollution and particulate emission in developing countries. For example, despite the initiative to rely on renewable energy sources, coal (with a total energy demand of 44%), oil (25%), and biomass (13%) gain the most importance in India’s current energy mix (ADB 2021a)

raising the risk that the country's air quality may worsen (IEA 2021a). Conversely, other Southeast Asian countries such as Indonesia, the Philippines, and Viet Nam continue to depend on coal-fired power plants to meet their energy demand (IEA 2019). Among the Asian countries, countries belonging to East Asia, the Pacific, and South Asia regions are the worst sufferers of ambient air pollution (Figure 7). In particular, India and the PRC are the worst sufferers from air pollution. To be specific, India and the PRC are home to some of the most polluted cities in the world. The average annual exposure to fine $PM_{2.5}$ in cities like New Delhi, Patna, and Ahmadabad in India and Shijiazhuang and Tangshan in the PRC are more than 10 times higher than the World Health Organization guideline of an annual mean of 10 micrograms per cubic meter (ADB 2021a). Although, there has been efforts to reduce ambient air pollution from vehicular emissions, the continued usage of inefficient diesel-powered vehicles and two-stroke engines result in the emission of nitrogen oxides (NOx) and particulate emission. Apart from that, the increase in the number of vehicles with volume of the road being constant, regular traffic congestion contributes to urban air pollution, since slower-moving traffic results in higher emissions per kilometer (km) (ADB 2021a).

In some Asian economies, residents in the rural region suffers from household air pollution (HAP). Incomplete combustion of traditional cooking fuels, such as firewood and solid biomass in inefficient cooking stoves, is the main source of HAP in Asia. Alarmingly, the particulate concentrations in kitchens in developing countries of Asia often exceeds the prescribed levels mentioned in the guidelines (Duflo et al. 2008). For example, the mean 24-hour $PM_{2.5}$ concentration in kitchen area of households using solid fuel in India is about 609 mg/m3 (Balakrishnan et al. 2013). Analogous evidence are also observed by Dasgupta et al (2004) and Zhang and Smith (2007) in Bangladesh and the PRC respectively. Despite the alarming health effects of HAP, about 3 billion people globally continue depending on dirty cooking fuels to meet their regular household energy demand (World Health Organization 2018), majority of them residing in India and the PRC (Bonjour et al. 2013). Further, about 2.8 billion households (among which 0.5 billion resides in urban areas) have reported to find commercial clean fuels to be expensive or irregularly supplied, thus making them less attractive to use (Jeuland et al. 2015). Without dramatic changes through policy interventions, the number of individuals relying on dirty cooking fuels is expected to remain roughly the same through 2030 in developing countries (IEA 2017).

Figure 7 : Death Rates Because of Air Pollution in 2017



Note: Countries in the South Asia region include Afghanistan, India, Bangladesh, Bhutan, Pakistan, Maldives, Nepal, and Sri Lanka. On the other hand, Australia; Brunei Darussalam; Cambodia; the People's Republic of China (including Hong Kong, China; and Macau, China); Fiji; Indonesia; Japan; Kiribati; the Democratic People's Republic of Korea; the Republic of Korea; the Lao People's Democratic Republic; Malaysia; Marshall Islands; Micronesia; Mongolia; Myanmar; Nauru; New Zealand; Palau; Papua New Guinea; the Philippines; Samoa; Singapore; Solomon Islands; Taipei,China; Timor-Leste; Thailand; Tonga; Tuvalu; Vanuatu; and Viet Nam consist the East Asia and Pacific region. Therefore, countries in Southeast Asia region (consisted of Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste, and Viet Nam) will be included under the East Asia and Pacific region. We have consistently followed this classification in Figures 7–9. Source: Ritchie and Roser (2019b, 2019c)

B. Water Pollution Issues in Asia

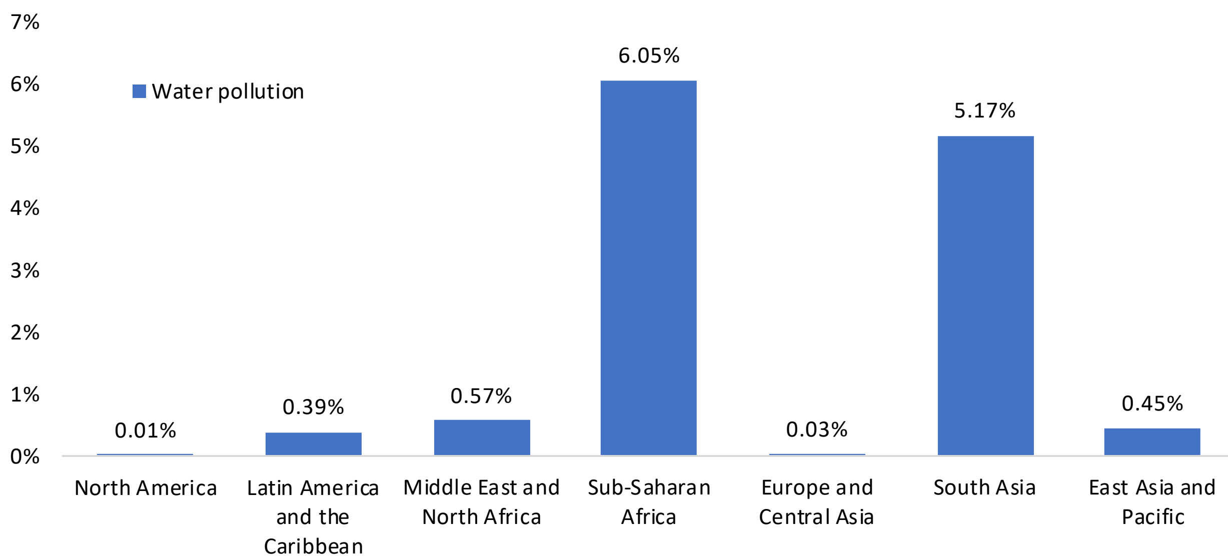
Increasing water pollution from household, industrial, and agricultural activities is a major environmental and health issue in Asian countries, particularly in the developing and underdeveloped economies. The death from unsafe water is quite high, particularly in countries belonging to the South Asia region (Ritchie and Roser 2019a) (Figure 8). Rapid and unplanned urbanization, large-scale irrigation, increase in of agrochemical consumption, as well as high sediment loads are significant sources of nonpoint source water pollution (ADB 2021a, and Chakraborty and Mukhopadhyay 2014). Apart from that, lack of treatment facilities, financial resources, and well-defined policies resulting in insufficient treatment and management of wastewater from both households and industrial users also aggravates the problem (Sato et al. 2013). Of the 144 cubic km of wastewater generated annually in Asia, 37% is generated in the PRC, 27% in South Asia, 20% in Japan, and 6% in Southeast Asia with only about one-third of the wastewater being treated (ADB 2021a). Among the Asian economies, India, Indonesia, and the PRC have the highest production of municipal wastewater with Malaysia and the PRC having the highest rates of wastewater treatment (Malik et al. 2015).

Biological oxygen demand (BOD) is a key indicator of water pollution from organic pollutants; the higher is the BOD level, the more polluted is the water. Among the different Asian countries, the PRC has the highest BOD levels (8.82 million kilograms [kg]/day) (ADB 2021a). Although there has been a significant positive correlation observed between the growth of GDP and the growth of BOD in all Asian countries,

Thailand and Viet Nam have shown a significantly high increase in BOD with respect to the increase in GDP. From 1998 and 2006, BOD emissions in Thailand grew by 87% and by 255% in Viet Nam. In comparison, GDP growth rate was 48% Thailand and 74% in Viet Nam (Chakraborty and Mukhopadhyay 2014).

There are no explicit programs in Asia for pollution through water discharges that have revenue implications. However, there are few country-specific programs that address this issue. For example, policies such as pollution discharge fee in the PRC and Water Cess Act in India imposed to mitigate water pollution from discharge generates revenue. These are discussed in detail in the subsections D.2 and D.3.

Figure 8: Share of Deaths from Unsafe Water Sources in 2017



Source: Ritchie and Roser (2019a)

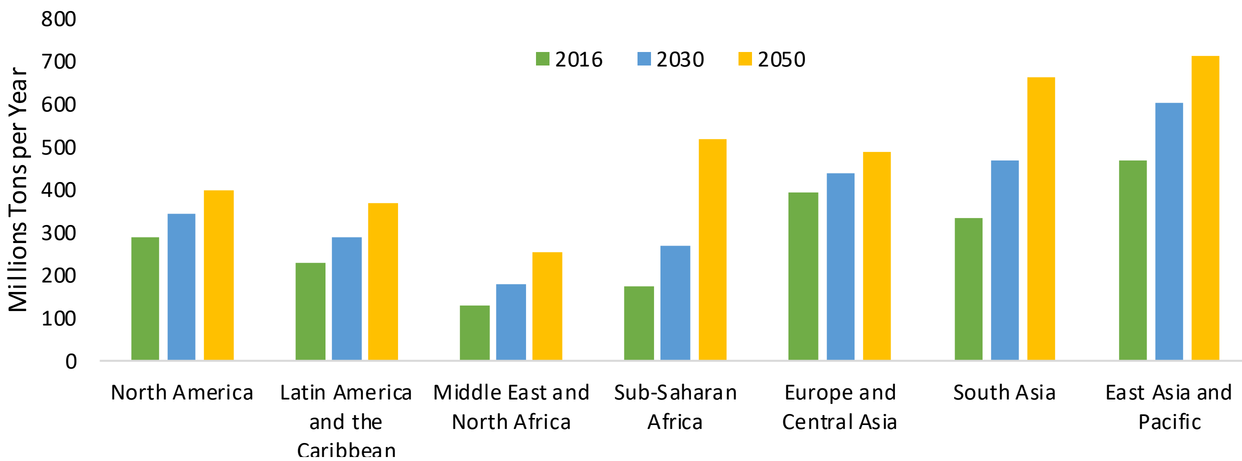
C. Waste Management Issues in Asia

With a population of 4.5 billion people and rapidly rising disposable incomes, Asia has witnessed an unprecedented increase in consumption levels (ADB 2021), resulting in an increase in waste generation. While the urban population of Asia in particular is growing exponentially at a rate of 1.5% annually, the associated exponential growth in waste generation is pushing the Asian cities beyond their solid waste management capacity (ADB 2021 2020). Municipal solid waste comprises the majority of the waste generated in Asia. The world generates about 2.01 billion tons of municipal solid waste annually, with at least 33% of that—extremely conservatively—not managed in an environmentally safe manner (World Bank 2018).

There has been a positive correlation between income and waste generation (World Bank 2018). Therefore, it may be predicted that the global waste will grow to 3.40 billion tons by 2050, exceeding the

population growth in the same period. To be specific, in Asia, about 1.2 billion tons of municipal solid waste was generated in 2016, and this figure is anticipated to increase to 1.5 billion tons by 2030, and 1.9 billion tons by 2050 (ADB 2021 and World Bank 2018). Waste production in East Asia, the Pacific, and South Asia is expected to more than double by 2025 from their 2012 levels (ADB 2021). Apart from that, the World Bank (2018) predicts that the total waste generation in South Asia is likely to double by 2050 from 2016 level (Figure 9). This is concerning to environmentalist because most of these municipal solid wastes are openly dumped and, hence, have a major negative impact on health and welfare, thus needing urgent interventions.

Figure 9: Projected Waste Generation by Region (million tons/year)



Source: World Bank (2018)

D. Current Experience and Practice

1. Sulfur Surcharge in Japan

Japan is one of the first countries that introduced charge on pollution. To address the air pollution issue in the 1970s, the Government of Japan introduced charge on sulfur dioxide (SO_2) to collect compensation for the people who suffered from the pollution.

The government determined the level of charge so that it can pay the compensation to all the people eligible for the compensation. In this scheme, the payment form polluters do not go to government budget. It has been used to pay the compensation. Therefore, in legal term, it is not called tax.

This sulfur charge was earmarked for the compensation because of an important reason. Around 1970, local residents started lawsuits against polluting firms all over Japan. These lawsuits include Minamata or many air pollution trials, including the case of Yokkaichi city where the damage of the air pollution was most severe. The local residents needed compensation to survive while polluting firms wanted to finish lawsuits as soon as possible. Consequently, the Government of Japan created the scheme in which local

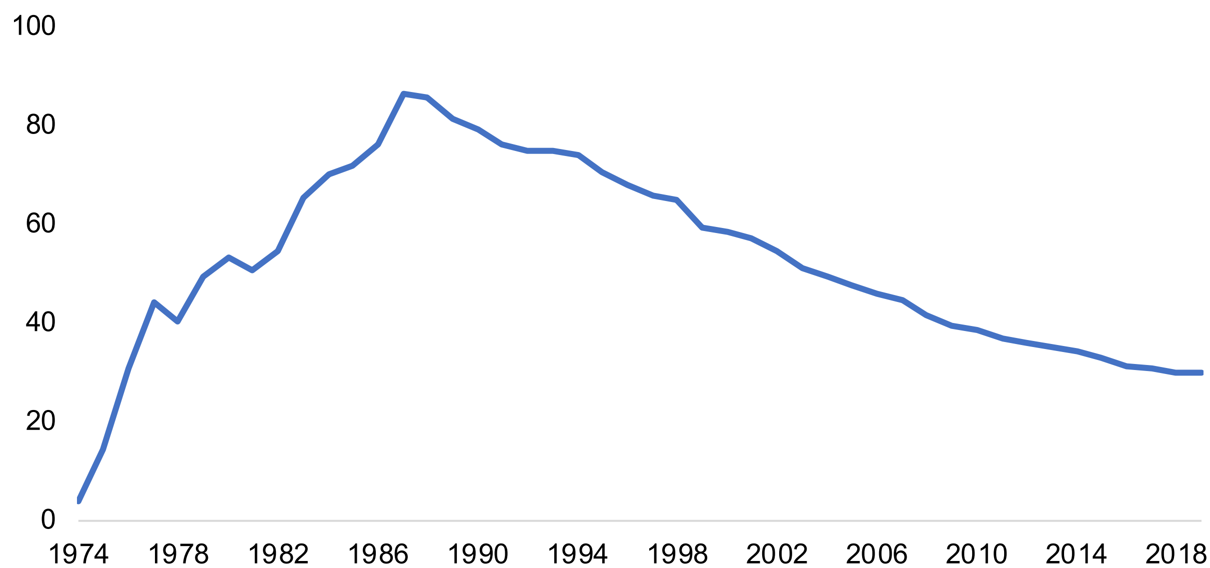
residents can earn compensation without lawsuits and polluting firms can compensate the people without being ligated in court (Environmental Restoration and Conservation Agency 1997).

In general, there are two types of sources of air pollution: fixed sources and mobile sources. In the case of Japan, the government decided that fixed sources are responsible for 80% of the damage and mobile sources for 20%. For fixed sources, large facilities must pay the charge based on their monitored emissions if they are located in designated areas such as Tokyo or Osaka. The level of levy differs across regions. In dirtier areas, facilities faced higher level of charge by one unit of pollution.

Mobile sources, user of automobiles, must also pay the sulfur charge because automobiles were also responsible for the pollution. The owner of automobile pays "automobile tax" every year. The amount of the tax depends on the weight of the vehicle, not on the usage of vehicles or gasoline consumption. This tax was used for the compensation.

Initially, 12 regions were designated. Later, it was expanded to 41 areas in 1978. The amount of the compensation reached 100 billion yen and the number of facilities exceeded 8,000 (Environmental Restoration and Conservation Agency 1997).

Figure 10: Revenue from Sulfur Charge in Japan (¥ billion)



Source: Environmental Restoration and Conservation Agency's website.

Figure 10 shows how the payment of sulfur charge changed over time. The total amount increased in the 1970s and the 1980s when the Japanese economy had a relatively high growth rate. The Environmental Restoration and Conservation Agency (1997) demonstrated how the sulfur charge promoted the adoption of Flue Gas Desulfurization System which removes sulfur dioxides from emission, thereby contributing to the improvement of air pollution in Japan. As the situation of air pollution improved over years, the number of the victims decreased as the air quality improved and, consequently, the amount of compensation needed decreased. After 1990, the total amount kept decreasing.

2. Pollution Charge in the People's Republic of China

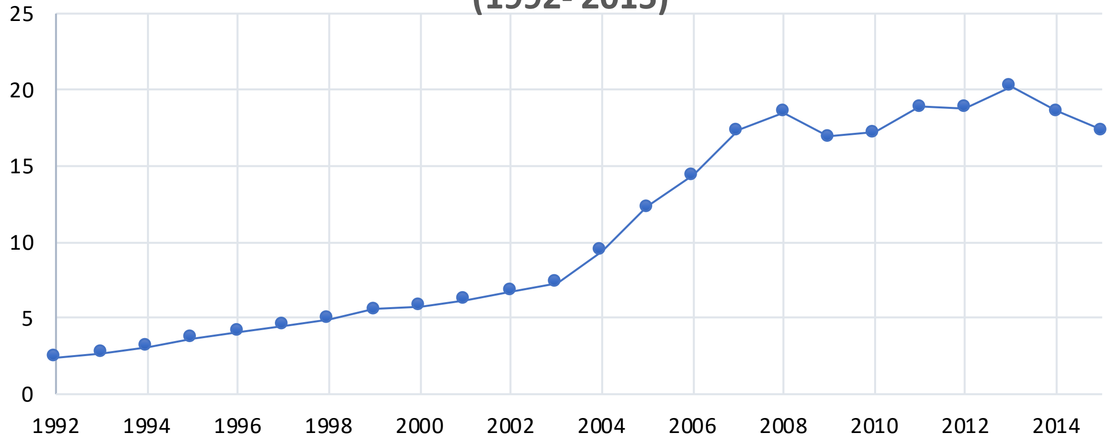
The PRC has a long history of collecting a pollutant discharge fee (PDF). Following a polluter-pays principle, the earliest legislation on PDF was promulgated in Article 18 of the "1979 Environmental Protection Law of the People's Republic of China (for Trial Implementation)", which indicated that a PDF will apply when the pollutant discharge exceeds the limits set by the state, taking into consideration of quantity and concentration of the pollutants released into the environment (Huang et al. 2020). The policy was further clarified in the "Provisional Measures for Collecting Pollution Fees (PRC State Council 1982)". During the early years of implementation, the charge limit set by the state was relatively low and did not distinguish different kinds of pollutants (Zheng and He 2021, He et al. 2020, and Huang et al. 2020).

After 20 years of implementation, the government updated the regulation on PDF and introduced the "Regulation on Pollution Discharge Fee Collection, Usage, and Management", also called the "Regulation" in July 2003, which serves as the legal basis for PDF collection until the Environment Protection Tax (EPT) was enacted in 2016. In the 2003 "Regulation", PDFs were increased from about CNY0.04 to CNY0.6 per kg of pollutant equivalent value. After the implementation of the 2003 "Regulation", a total of CNY9.4 billion was collected in 2004, a 28.9% increase from the amount collected in 2003. This revenue further increased to an average of CNY15.0 billion in 2005–2007 (Figure 11). In 2015, an estimated CNY17.3 billion (about US$2.5 billion) in pollution discharge fees was reportedly collected from some 280,000 businesses (Library of Congress 2017).

While the 2003 "Regulation" helped increase revenue and constrained firms' polluting behavior, challenges continued to rise. As local governments have the greater control in PDF collection, different provinces have different practices in terms of standards, assessments, and categorization of pollutants discharge, and management and supervision of PDF usage. Some local governments may even exempt some large enterprises from paying PDFs after a tradeoff between charging PDFs and higher tax revenues from the businesses. These prompted reassessment of the PDF policy and led to the enactment of the PRC's first Environment Protection Tax Law in 2016 (Huang et al. 2020).

The PRC's EPT formally came into force on 1 January 2018, bringing the 4 decades of implementation of PDF to an end. Under the Environment Protection Tax Law, taxpayers include "enterprises, public institutions, and other business operations that directly discharge taxable pollutants" within the PRC's territory. The EPT applies to the same set of pollution categories covered by PDF, which includes water, air, noise, and solid wastes. However, pollutants from certain sources are not covered under the EPT. For example, pollutants discharged from agricultural production, motor vehicles, ships, aircraft, and legitimate urban sewage treatment plants are exempted from taxation. While the PRC is working to address climate change challenges and shift towards a low-carbon development, these efforts partly help solve air pollution issues from coal burning. Although carbon dioxide, the main target of the ETS, is excluded from the EPT pollutant list. Thus, the PET targets to reduce air pollutants emissions, such as carbon monoxide, SO_2, PM_{10}, and $PM_{2.5}$ amongst other pollutants, while the reduction of CO_2 emissions is in a larger scale and covered by other initiatives on climate change, such as ETS.

Figure 11: Revenue Collection from Pollution Discharge Fee (1992- 2015)



Source: China Council for International Cooperation on Environment and Development (CCICED). 2009. Economic Instruments for Energy Efficiency and the Environment. *CCICED Policy Research Report 2009*. CCICED Annual General Meeting, 11–13 November. https://foes.de/pdf/Research_Report_EN_FINAL.pdf (accessed 23 September 2021).

Compared to PDF, EPT has improved monitoring, collection, and accountability at the local level. For example, under the PDF, all companies pay the same uniform fee, regardless of their polluting levels, whereas under the EPT, the tax rate vary depending on the level of pollution, which means light polluters enjoy a preferential treatment relative to heavy polluters. For instance, when a polluter's emission is 30%–50% less than the permitted pollutant disposal standard, the polluters can get a 25%–50% discount from the payable amount. The EPT also offers greater incentive for compliance. Under the PDF, nonpayment of PDF could result in a fine of up to three times of PDF while under the EPT, nonpayment of EPT can result in a fine of up to five times the tax, with higher penalties for serious offenders (Cicenia 2018). Moreover, under the EPT, both the tax bureaus and environment protection authorities are involved in the regulation, with the former in charge of collection while the latter monitor pollutants and provide statistics to help tax bureau better supervise tax declarations. According to OECD statistics, the PRC's EPT revenues recorded at CNY15 billion in 2018 and CNY22 billion in 2019.

Some challenges still exist in the implementation of EPT. For example, the scope and coverage of the EPT can be improved with enhanced monitoring and pollution data. For example, according to Hu, Dong, Jiang, and Zhu (2020), as of 30 June 2018, only more than 4,000 taxpayers among the 50,628 pollutant-discharging companies in Yunnan province are covered by the EPT. This can also be the case in other provinces. This implies a narrower-than-expected coverage of the EPT collection, which limits the scope of environmental tax in helping reduce pollution. Thus, it is necessary to strengthen tax supervision to achieve tax fairness and boost tax collection (Ji et al. 2021).

Existing evidence shows that environmental taxations help to generate positive environmental and health externality. For example, Wang et al (2020) evaluated the effects of different scenarios of environmental taxation policies in the PRC, and find that raising environmental taxation on pollutants like SO_2, NOx, soot, and dust will help reduce emission and air pollution effectively. Their estimation shows that gradually

raising environmental tax on pollutants are more cost-efficient by mitigating potential negative impacts on the economy. Zhang et al (2019) evaluate the policy performance of the PRC's EPT launched in 2017, which gives local governments more scope to set pollution tax rates based on local conditions. They find that, compared to the uniform tax rate system, this differentiated tax rate system is more efficient in increasing health benefits and also help address inequalities of environmental health burden among different regions.

3. Emissions Trading Schemes and Pollution Charges in India

India has been implementing various ETSs to address the issue of local pollution problems. India's Ministry of Environment and Forests along with the country's Central Pollution Control Board and their state counterparts had jointly launched a pilot ETS mechanism with a focus on particulates impacting human respiratory health like SO_2, NO_x, and suspended particulate matter in February 2011 in Gujarat, Maharashtra, and Tamil Nadu. The primary reason for choosing these three states is that they have the highest number of manufacturing facilities in the country.

The pilot ETS covered 1,000 facilities in close proximity to the largest metro areas in Gujarat, Maharashtra, and Tamil Nadu. The facilities were selected based on geographic area, sector, and parameters like boiler capacity and fuel type that are indicative of capacity for pollution emissions (Duflo et al 2010). State pollution control boards determined the precise criteria for eligibility and enforced the ETS as the only form of regulation for particulate matter for all eligible industries. The pilot scope included a significant fraction of large particulate emitters in each metro area covered, which are a small share of all industries in each state. After this, the regulator distributed the emission permits to the facilities with the ceilings, and thus the facilities have options of either complying to the limits or trading additional permits through specialized platforms.

Influenced by globally successful cap and trade mechanisms such as the United States SO_2 trading program, this pilot program was introduced to create ambient air quality and incentivize the industries to achieve the National Ambient Air Quality Standards. The total budget for the design and implementation of this pilot ETS program is US$57.7 million, of which the installation cost is 95% of the overall budget (MOEF 2011).

Since air pollution from particulate emission is a severe issue in India, India is focusing more on reducing particulate emission than carbon emission. To do so, India has implemented a pilot ETS for particulate emissions which is a first of its kind in the world.

As a continuation to the pilot ETS program of 2012, the Gujarat Pollution Control Board (GPCB) in association with National Commodity and Derivative Exchange has launched a large-scale pilot ETS program for particulate emission in July 2019 in 158 plants in Surat (Greenstone et al. 2019). This pilot ETS program is first of its kind in the world for focusing only on the particulate emissions. After a mock training of 2 months, the pilot ETS was implemented in September 2019.

Before the implementation of the ETS program, the emission of the 158 plants was 362 tons on average, but with the implementation, the GPCB has set the cap at 276 tons (Greenstone et al. 2019). Out of the permits, the GPCB has grandfathered 80% of them, while the rest 20% was auctioned at a floor price of ₹5 per kg (GPCB 2019). To ensure smoother trading of permits, the permit price ceiling was imposed at

₹₹100/kg while the floor was maintained at ₹₹5/kg (GPCB 2019). The National Commodities and Derivatives Exchange e-Markets Limited (NeML) acts as the platform for the auctioning and permit transaction (GPCB 2020). The NeML determines the detailed market operation manual including the rules of auction clearance and the like (GPCB 2019). Apart from this, permit holding limit and permit selling limit were set up to which the participating industries had to abide by. The permit holding limit which was set up at greater than 150% of initial allocation or the 5% of the total market-wide cap and the permit selling limit was limited to 90% of initial allocation (GPCB 2019).

There is regular monitoring, and the noncompliant plants are penalized. The levels of penalty vary across the plants: US$2700 for small-scale units, US$4100 for medium-scale units, and US414,000 for large-scale units (GPCB 2019).

Greenstone et al. (2019) have projected that the pilot ETS is expected to reduce the particulate emission by 29% as well as lowering the cost of reducing particulate emissions for industries. In reality, GPCB (2020) has reported that the particulate emission has reduced by 21% over a period of 5.5 months.[6] Further, as a result of this ETS, the individual as well as the average profit of the industries are expected to increase. This pilot ETS for particulate emission is likely to be implemented in other parts of Gujarat as well as in other Indian states that have high particulate emission and large industrial cluster.

In India, water pollution is also a major problem that has increased manifold in recent years mainly because of rapid and unplanned industrialization and urbanization (Kumar et al. 2017). To control water pollution, the Water (Prevention and Control of Pollution) Act was sanctioned in 1974 and later amended in 1988 (CPCB 2019). This act provides a guideline for maintaining and/or restoring the purity of the water in the country. In addition, the Water (Prevention and Control of Pollution) Cess Act was implemented in 1977 that provides a guideline for imposition as well as collection of cess on water consumption for industrial purposes as well as by local authorities (State Pollution Control Board), with a view to augment the resources of the central board and the state boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974 (Government of India 1977). This act was last amended in 2003. Table 5 presents a brief overview of the different cess rates implemented under the amended Water (Prevention and Control of Pollution) Cess Act 2003.

Table 5: Cess Rates Implemented Under the Amended Water Cess Act 2003

Purpose for which water is consumed	Maximum cess rate under Act 1977	Maximum cess rate under amended Act 2003
Industrial cooling, spraying in mine pits or boiler feeds	5 paise/kiloliter	10 paise/kiloliter
Domestic purpose	2 paise/kiloliter	3 paise/kiloliter
Processing whereby water gets polluted and the pollutants are (i) easily biodegradable, or (ii) nontoxic, or (iii) both nontoxic and easily biodegradable.	10 paise/kiloliter	20 paise/kiloliter

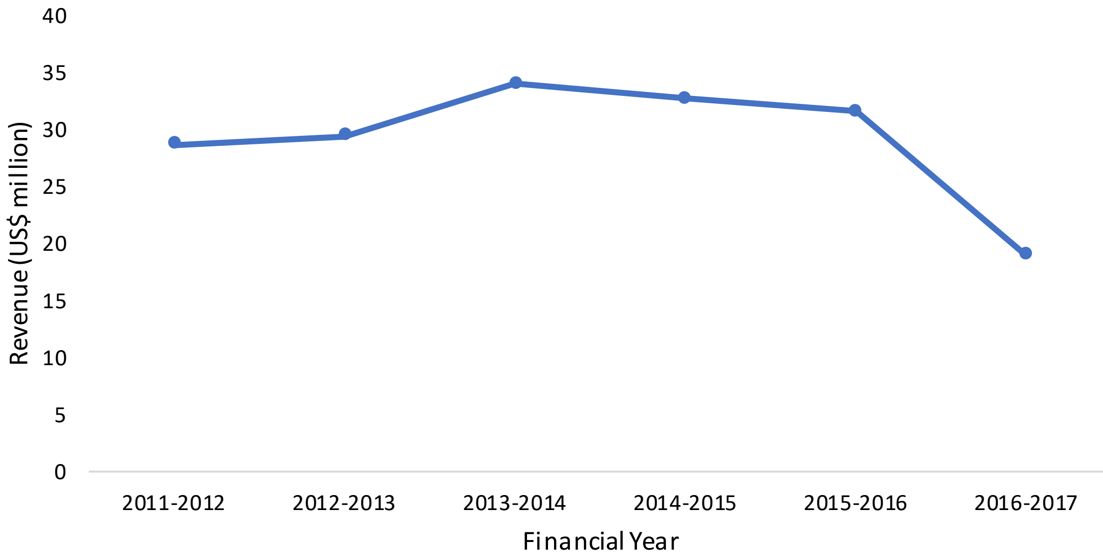
[6] Emission trading was suspended in the period 26 March 2020–30 November 2020 because of the nationwide coronavirus disease (COVID-19) lockdown. The trading of permits has begun from 1 December 2020 (GPCB 2020).

Purpose for which water is consumed	Maximum cess rate under Act 1977	Maximum cess rate under amended Act 2003
Processing whereby water gets polluted and the pollutants are (i) not easily biodegradable, or (ii) toxic, or (iii) both toxic and not easily biodegradable.	15 paise/kiloliter	30 paise/kiloliter

Note: US$1=₹46.58 (as on 2003); 100 paise = ₹1
Source: Ministry of Law and Justice (2003).

According to the amended Act 2003, the Government of India can exempt an industry from paying the cess by considering the following factors: nature of raw material used; nature of manufacturing process employed; nature of effluent generated; source of water extraction; nature of effluent-receiving bodies; and the production data, including water consumption per unit production, in the industry and the location of the industry (Ministry of Law & Justice 2003). The rules for the imposition of penalties for late payment as well as nonpayment have not been changed in the amended act. In case of delay of payment, the consumer has to pay an interest on the amount to be paid at the rate of 2% for every month or part of a month comprised in the period from the date on which such payment is due till such amount is actually paid (Government of India 1977). In case, there is a nonpayment within the date specified, then the State Pollution Control Board may impose a penalty in the form of a monetary fine with the amount not exceeding the cess amount in arrears. However, before the implementation of the penalty, the defaulters shall be given a reasonable opportunity of being heard in front of the State Pollution Control Board. After such hearing, if the authority is satisfied that the default was for any good and sufficient reason, no penalty shall be imposed under this section (Government of India 1977). The cess amount generated is a source of revenue for both the state and central pollution control boards. Figure 12 presents revenues generated through the water cess during the period of 2011–2017. Up to 80% of cess amount collected by State Pollution Board is reimbursed to them for meeting their approved expenditure requirements. The remaining 20% are retained by the Government of India for taking up specific projects in the country through Central Pollution Control Board, subject to approval by the Government of India (MOEFCC 1977). However, the Government of India, vide its Taxation Laws Amendment Act, 2017, has abolished the water cess levied under the provisions of the Water (Prevention & Control of Pollution) Cess Act, 1977, effective from the date of implementation of GST (Maharashtra Pollution Control Board 2017)

Figure 12: Revenue Generated from Water Cess Act, 2003 Over the Years (US$)



Sources: Union budget reports (2013–2014, 2014–2015, 2015–2016, 2016–2017, 2017–2018, and 2018–19).

E. Other Energy-Related Tax (Fuel Excises Such as Gasoline Tax)

Many countries have adopted gasoline taxes and fuel excise though they were not necessarily environmentally motivated. However, these taxes can also impact household decisions on mode of transport, vehicle ownership, distance travel by car, adoption of fuel-efficient cars (e.g., hybrid/electric car) etc.; and hence can influence environmental outcome. Such decisions are also affected by the quality of public transport system, households' incomes, and the effective price of goods (e.g., gasoline price after tax) in each country/location.

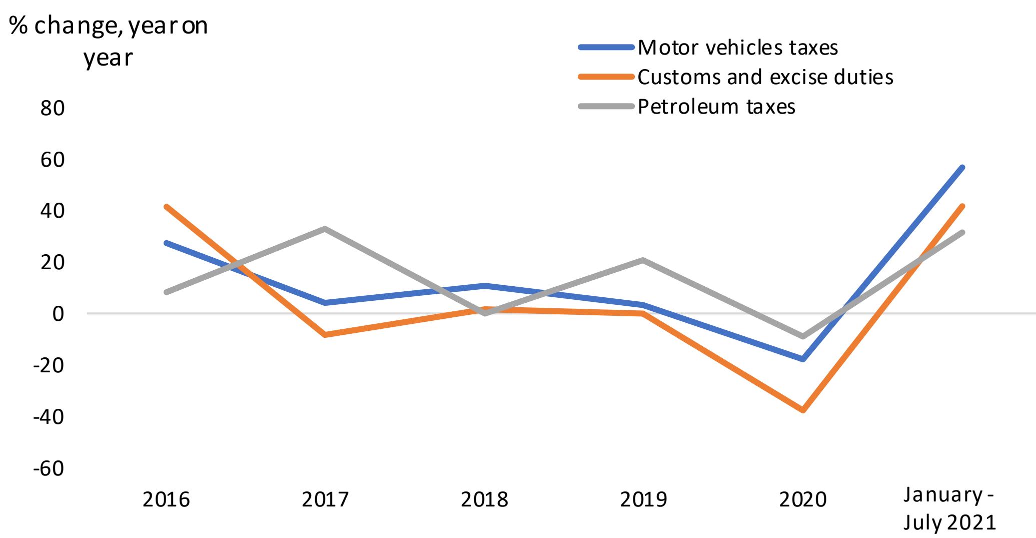
Japan has been charging tax on gasoline and diesel for decades. The gasoline tax is ¥53.8 per litter and diesel tax is ¥32.1 per litter. Initially, these taxes were earmarked and used for the construction of road based on the "beneficiary pays principle". Later, the government stopped earmarking and the revenue goes to general accounting after the reform under the Koizumi administration. In 2020, combined with automobile tax which is charged on the possession of vehicles, automobile-related tax amounts to ¥9 trillion, which accounts for 8.1% of the tax revenue in Japan (Japan Automobile Manufacturers Association 2020). Gasoline tax amounts to ¥2.4 trillion and diesel tax amounts to ¥0.96 trillion. Combined with consumption tax, half of the automobile-related tax comes from their use of vehicles (not the possession of vehicles). Therefore, this is a large portion of the budget for the Government of Japan.

Japan's gasoline tax account for more than a third of gasoline price, thereby influencing people's choice of residential location and mode of transport. Generally speaking, Japanese cities have high population density and good public transport. These public transport and urban structure may partly result from high gasoline tax.

In addition to gasoline tax, automobile tax can induce people's choice of type of vehicles. In Japan, owners of automobiles must pay tax for obtaining vehicle. The Government of Japan has lowered this automobile tax on environment-friendly vehicles. For example, they exempted the tax for electric vehicles or fuel cell vehicles. In this way, governments can help the diffusion of environment-friendly vehicles and reduce CO_2 emissions and other air pollutants from vehicles.

Singapore is also charging tax on petrol. Along with measures to encourage investments and innovations in energy-efficient technology and equipment, Singapore has been motivating emission awareness of households to avoid energy wastage and overconsumption through duties on petrol and diesel usage as well as encouraging low-emitting travel. On 16 February 2021, petrol duty rates were raised by 15 cents per liter for premium and 10 cents per liter for intermediate petrol to help shape consumer behavior towards a more efficient fuel usage. The expected revenue increase from the petrol duty changes is estimated at $113 million (Figure 13). However, to ease the transition to higher petrol prices, most of the revenue will be given out in the form of road tax rebates ranging from 15% (private cars) to 100% (commercial vehicles), which took effect from 1 August 2021 and until 31 July 2022. To encourage the use of public transport or low-emission travel, the government planned to extend the length of its rail network from 230 km in 2017 to 360 km by 2030. In March 2021, the government announced measures to support the adoption of electric vehicles, by lowering the upfront cost of an electric vehicle through rebates and revising the road tax framework for electric cars, to be implemented until 31 December 2023. This could further lower future revenue from fuel and other vehicle-related taxes.

Figure 13: Petroleum and motor vehicles tax revenues

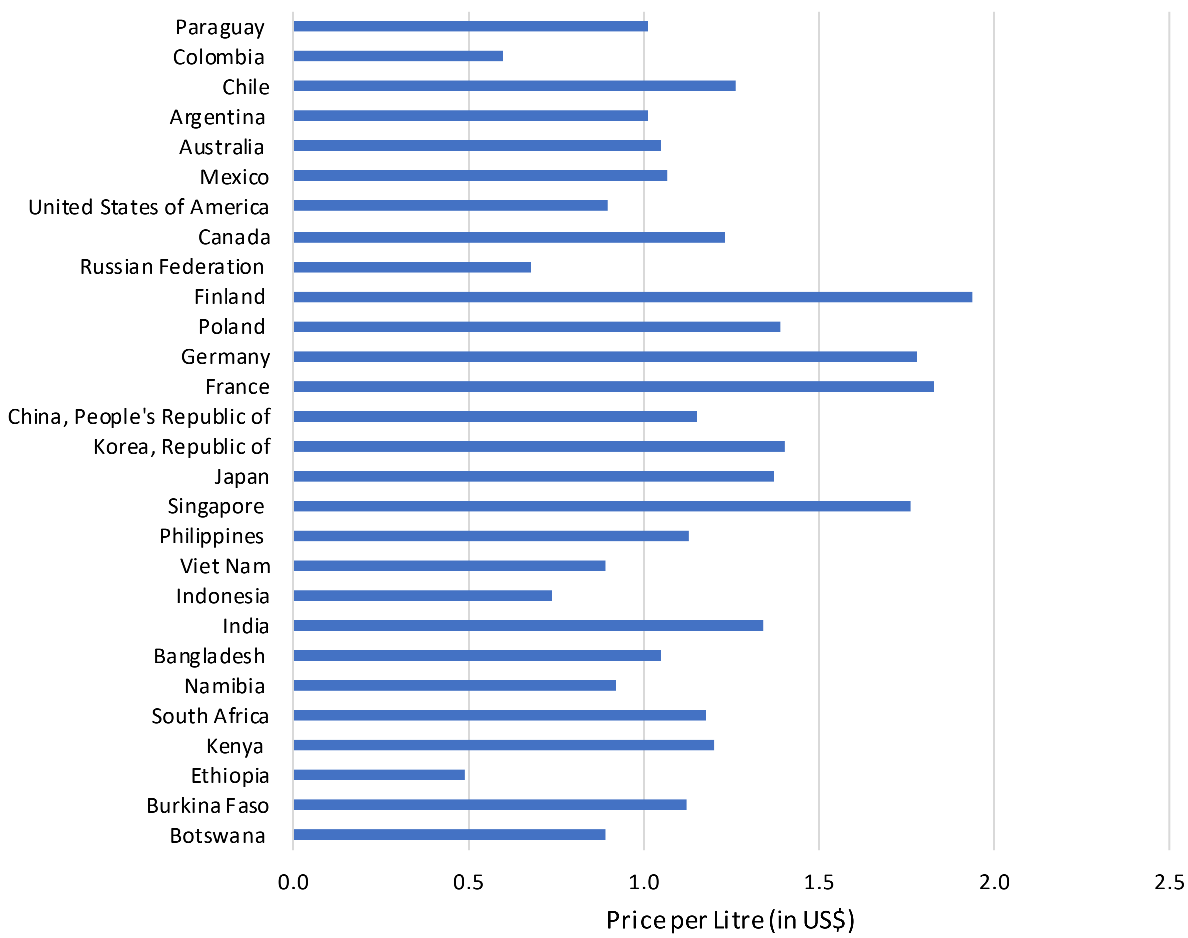


Souce: CEIC Data Company (13 September 2021)

There are also lots of variations in gasoline prices within Asia and the rest of the world. In Asia, as of June 2021, Singapore (and Hong Kong, China) seems of have highest gasoline price in Asia followed by the ROK and Japan. It is interesting to note that the price of gasoline in the ROK is higher than in Japan despite the ROK not having introduced carbon tax. Similarly, many other Asian countries have not introduced carbon tax and prices are relatively low compared to Singapore and Japan. However, gasoline

prices in India and the PRC are relatively higher than many countries in Africa that do not have carbon taxes. On the other hand, the gasoline prices in Chile, which introduced carbon tax in 2017, are relatively higher than the rest of the countries in Latin America. On average, prices in Latin America are lower than in Asia. The gasoline prices in Mexico, Canada, and the United States are lower than in Singapore, Japan, the ROK, and India. Europe has the highest gasoline prices compared to the rest of the world with the exception of the Russian Federation and eastern European countries. Figure 14 compares the gasoline prices in selected countries of Asia, Africa, Australia, Europe, South America, and North America as of June 2021. These variation of gas prices partly come from the variations in the level of gasoline tax.

Figure 14: Gasoline Price in Selected Asian Countries Compared with the Rest of the World



Source: Data download from www.globalpetrolprices.com published on www.statisticstimes.com.

IV. CHALLENGES AND OPPORTUNITIES IN IMPLEMENTING REVENUE RAISING POLICY FOR GREENER ASIA

Green policy instruments are attractive options for policymakers across Asia because they also help in raising revenue. However, there are several challenges that governments face in the introduction or the implementation of these policies. At the same time, green revenues provide opportunities to reform the tax system, thereby stimulating economic activities. This section discusses the challenges and the opportunities that the revenue-raising policy instruments can bring.

A. Competitiveness Issues

The introduction of environmental tax, including carbon pricing, is often accompanied by opposition from various stakeholders. One of their concerns is that the tax may cause loss of competitiveness. This is especially the case when energy-intensive sectors face carbon pricing. Since the introduction of a carbon pricing often contributes to increased energy prices, energy-intensive sectors are afraid of losing market shares to foreign competitors, which are not facing a similar tax. In this case, voluntary approaches for emission reductions could be envisaged, as it is the case in Japan (Arimura et al. 2019)

Economists have proposed several measures to address this issue. For example, in the case of carbon tax or energy tax, energy-intensive sectors are exempted in Japan. In the case of ETS, governments can allocate permits freely to energy-intensive sectors such as iron and steel, as it is the case in EU ETS. In Asia, free allowances are used in the ROK or the PRC pilot ETSs.

Another somewhat controversial measure is a border carbon adjustment mechanism, which consists in a carbon tariff or permit purchase requirement at the border. The example of the latter is CBAM proposed in EU ETS as explained in section II.C. Border adjustment has been also adopted in California ETS in the electric power sector, as the electric grid in California is connected to neighboring states (Fowlie et al. 2021).

In the case of ETS, free allowances such as grandfathering or benchmarking can be used as in EU ETS or other ETSs. If the grandfathering method is not enough for protecting the industry, output-based allocation (OBA) could also be used to address the issue. In the case of grandfathering, the number of free allowances does not change even when the production increases. In OBA, the number of free permits is increased when the production increases (Fischer and Fox. 2007). Takeda et al. (2013) examined the effectiveness of OBA in the Japanese economy and found that it is more effective in protecting the industry than carbon tariff.

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B. Distributional Impacts

While the objectives of carbon taxes and cap and trade programs are correcting the (negative) externality and internalizing the cost imposed on the society, such policy has distributional effect because such taxes have direct impact on the individual/household consumption through various channels. It may be even a more relevant issue for Asia (to be considered) given that majority of countries in Asia are lower middle-income countries. When designing the carbon tax (and cap and trade programs), it is important to consider ex-ante the distributional effect (regressive or progressive). Who ultimately bears the burden of

taxes is determined largely by the elasticity of goods/services (affected by the policy)[7] and may vary by household size, home size, appliance ownership, dependency on car and electricity infrastructures Cronin 2019).

The primary concern of carbon tax (or other emission cap programs) is the impact on the prices of final goods and services. Policy makers may argue that such distributional concerns can be mitigated by transfer programs. However, if transfer programs are not carefully designed, such rebate may undermine the efficiency of carbon tax. Further, the distributional impact of carbon tax may vary depending on whether the household consumption bundle includes goods that are targeted by the carbon tax. Currently, a majority of countries are directly imposing carbon tax on fuel (e.g., coal and gasoline tax), few of which poor households consume in developing countries. For example, coal tax may increase the price of electricity, but poor households do not heat or cool using air conditioners suggesting that coal tax is progressive (Parry et al. 2019). Similarly, Parry et al. (2019 report that Indian coal tax may be progressive because many are not connected to grid. Yusuf et al. (2015) also showed that the carbon tax in Indonesia is not regressive (Yusuf et al 2015). On the other hand, the carbon tax may be regressive in developed countries of Asia because of high share of household expenditure on energy, which was in the case of Ireland (Callan et al. 2009 and Verde et al. 2009), the United States (Fremstad 2019) and France, before revenue recycling (Bureau 2011). In developed Asia, it has been reported by Inoue et al. (2020), using historical data from 1980 to 2014, that Japanese households spend on average about US$60–US$95 per month on electricity and gas. Data from Cabinet of the Government of Japan shows that expenditures on electricity and gas constitute about 5% of consumption expenditure of poorest income quintile, while it only constitutes about 3% and 2% of consumption expenditure of electricity and gas, respectively. In other words, the burden of carbon tax is higher on poorer households in Japan. (Figure 14). Similarly, monthly average electricity consumption in Singapore is about 472 kilowatt-hours[8] Given the high share of expenditure on household energy, it is likely that the burden of carbon tax in Japan and Singapore may be regressive (or larger for poor than the rich households). Similarly, Jiang and Shao (2014) report that carbon tax will be regressive, and that the extra burden for both rich and poor is about 1% because of carbon tax on energy expenditure.

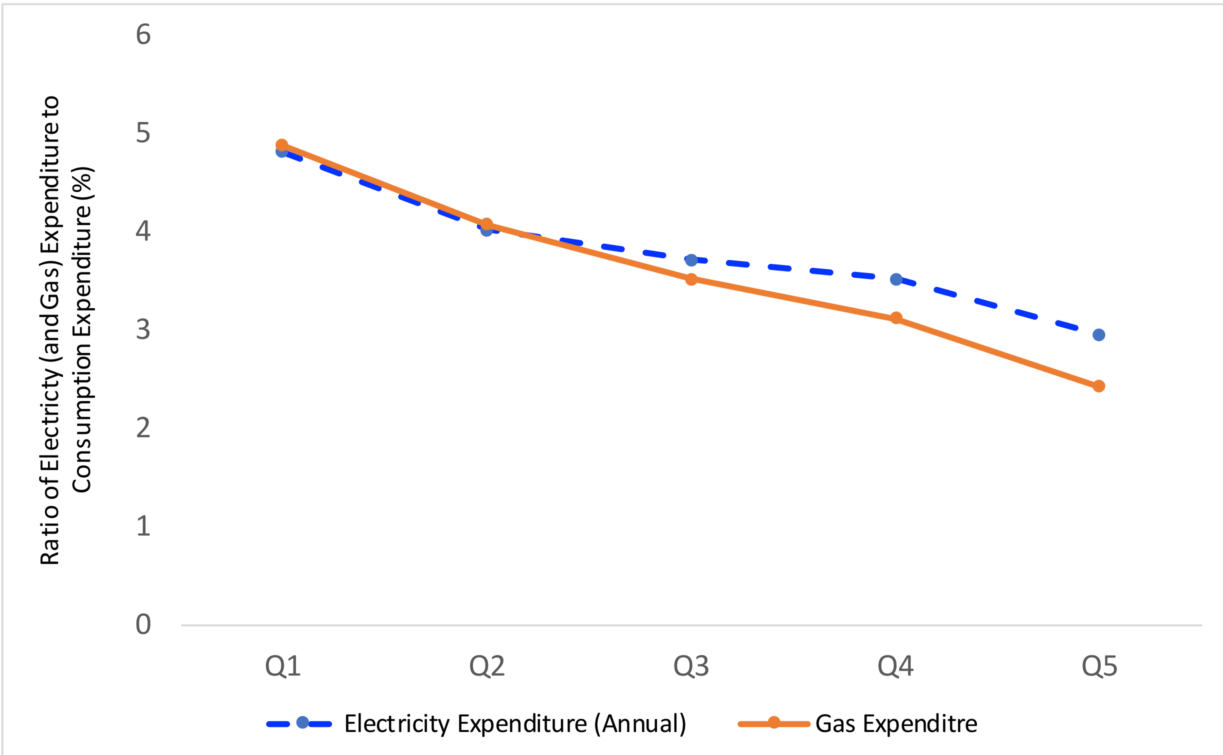
From the policy perspective, it is important to recognize that a carbon tax will affect households through factor and commodity prices as well as taxes and transfers (Timilsina 2018). The increase in factor prices benefits households while the increase in commodity reduces household welfare. A study by Dissou and Siddiqui (2014) reports that inequality reduces because of increase in factor prices while inequality increases because of commodity prices. This evidence suggests that revenue recycling or transfer programs are important components of carbon tax from the distributional point of view. Among many methods of transfer programs, rebate (or lump-sum rebate) and cut in taxes are widely practiced. Evidence suggests that lump-sum rebate or transfers benefits lower-income households most than the tax cut, hence making carbon tax more progressive (Timilsina 2018). At the same time, such revenue recycling appears to be less costly than what most economists and policy makers think. For instance,

[7] The economic agent with inelastic demand (or supply) bears tax burden most, while an agent with elastic demand (or supply) can avoid or bears the least (tax) burden. Thus, while higher price (induced by tax) may be effective for correcting the externality and internalizing the cost (on society), this has direct effect on household budget and, subsequently, the welfare of the households.

[8] https://www.ema.gov.sg/cmsmedia/8RSU.pdf.

Mathur and Morris (2014) suggest about 11% of tax revenue is sufficient to improve the welfare of the two poorest deciles in the United States.

Figure 15: Share of Household Expenditure on Electricity and Gas by Income Quantile



Note: This graph is computed based on the 2020 consumption data Cabinet Office's 家計調査.

Source(s): https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200561&tstat=000000330001&cycle=7&tclass1=000000330001&tclass2=000000330019&tclass3=000000330020&tclass4val=0

Other instruments that support the implementation of tax revenues on carbon reduction include some rebate or subsidy programs or initiatives. This program provides incentives for low-carbon and energy efficiency consumptions and investments. For example, the PRC introduced China Energy Label in 2005, and implemented a few initiatives that provide subsidy and rebate in both urban and rural areas to support energy-efficient products, such are water heater, refrigerator, air-conditions and electric cars. All such initiatives complement ETS and the PRC's efforts in reducing energy intensity. Japan has also had a similar program, called "eco-point program" in which consumers were able to obtain rebate for purchasing energy-efficient appliances (Morita and Arimura 2015).

There have been several discussions regarding designing the optimum structure of rebates, particularly for low-income and middle-income countries who apparently suffer the most from imposition of carbon pricing instruments. Stone (2015) suggests that, while designing a robust low- and moderate-income

climate rebate program to mitigate the effects of carbon, policymakers should consider the factors like size and scope of the rebate: how large the rebate should be and how eligibility should be set.

C. Monitoring, Reporting, and Verification

To introduce environmental tax or carbon pricing, governments must be able to monitor the emissions of pollutants or CO_2. For developing economies, monitoring pollutants or emissions may not be an easy task. Regulators or emitters must install equipment to monitor pollutants, and this may require technological capacity and cost.

Alternatively, governments can charge tax on fossil fuels based on the polluting content in the fuel. For example, the amount of carbon emissions from fossil fuels can be determined by the carbon content of each fuel type. Thus, governments can charge different tax rate by fuel type without monitoring emissions from economic activities. This is the method adopted in the case of the Japanese carbon tax.

In the case of ETSs, MRV is a fundamental base ensuring that the regulation works and that the markets of permits operates smoothly. If MRV is not accurate, regulators cannot measure the emission reduction, and thus cannot implement regulation properly. Moreover, if participants in the market cannot trust the quality of permits, they may not be willing to purchase permits, and thus the liquidity of markets will be reduced. Thus, MRV is an essential element for ETS markets to work effectively.

The integrity of MRV requires effort, especially at in its infancy. Chinese local pilot ETSs are working on its improvement (Li et al. 2021). The experiences of the pilots in the PRC, Japan, and the ROK are useful for other Asian countries.

It should be noted that governments could use the private sectors to monitor and verify the amount of CO_2 emissions as a third-party verifier. Governments can issue guidelines in the calculation of CO_2 emissions based on the energy use from facilities. Based on the guidelines, many governments accredit verifiers of CO_2 emissions. These accredited verifiers, working as third parties, can check and confirm the validity of CO_2 emission measurements. Based on the verified emissions, facilities can participate in the market of ETS.

One should note that the proper and accurate measurement of pollution emissions is critical in implementing environmental regulations. Therefore, the establishment of MRV system is beneficial for the fiscal department as well as for environment agencies.

D. The Use of Revenue and Potential for Tax Reform

The use of revenues for environmental tax or permit auction can be categorized into two types. First, government can earmark the tax revenue for specific purpose. For example, the carbon pricing revenue can be earmarked for promoting low carbon technologies. In Japan and Singapore, carbon tax revenues are used for the promotion of renewable energy or energy efficiency. In Japan, subsidies for Joint Crediting Mechanism (JCM) (Sugino et al. 2017) are also coming from the revenue of the carbon tax. Similarly, the revenue of pollution tax can be used to address the issue of the environmental damage. Sulfur charge in Japan has been used to compensate people who have suffered from the air pollution. In

general, this way of using the tax revenue can be politically acceptable among the general public and stakeholders who will be influenced by the tax burden.

Second, governments can use the tax revenue as a general account budget. In this scheme, governments can treat it as additional tax revenue and the revenue is not earmarked. The government can also recycle the environmental tax revenue by reducing other tax, such as corporate tax or income tax. Corporate tax is distortionary in the sense that it can decrease the incentive of investment by firms. By reducing such distortionary taxes, governments can stimulate economic activities by increasing investment or consumption while reducing emissions as well. This is known to be double dividend of environmental tax/carbon pricing. If the net gain from the tax reduction outweighs the burden of environmental, tax, i.e., the net gain is positive, it is referred as “strong double dividend”. Otherwise, it is known as “weak double-dividend” (Goulder 1995).

Some European countries such as Germany (Beuermann and Santarius 2006) or the United Kingdom (Agnolucci 2009) have adopted this kind of the tax reform when they introduced the energy tax. Recently, the carbon tax in British Columbia (Canada) also used this scheme successfully. Yamazaki (2017) showed that the revenue recycling of carbon tax in British Columbia led to the increase of the employment, while the carbon tax reduced emissions.

In Asia, no country has adopted this type of environmental tax reform. Several economic studies investigated the possibility of double dividend. In the case of Japan, Takeda and Arimura (2021) showed that there is possibility for the strong double using a dynamic economic model.

In general, ETS is a policy instrument that has an advantage in achieving an emission target, while carbon tax has an advantage in raising revenue. It is partly because the revenue from ETS permit auction is difficult to predict because the allowance price is difficult to predict also. Moreover, the size of the revenue may change drastically if the allowance prices fluctuate.

In sum, for the revenue purpose, carbon tax may be a better option than ETS is. With ETS schemes, free allowances are often used to deal with the competitiveness and carbon leakage issues, thereby reducing the source of the revenue. Moreover, ETS tends to target larger emitters because of bureaucratic burden and, consequently, is likely to have a limited scope of the emission sources compared to tax. With ETS, it is easier to control emissions and, thus, it is effective to reduce emissions. With ETS, it is easier to lower the burden for the industries with free permits. One should also note that carbon pricing is set to be low in Asia compared to the European Union. Moreover, some countries are adopting ETS because the European Union is promoting ETS.

E. Tax Level and Stability of the Permits

In introducing carbon or environmental tax, the choice of tax level is crucial. In many cases, it is wise to start from a low level so that industries and households can adjust to the tax relatively easily. Governments can increase the tax level gradually to the desired level. This gradual introduction was adopted in the case of carbon tax in Japan and Singapore. It should be worth noting that

environmental/carbon tax is not effective in emission reduction though it is easy for households and industries.[9]

In the context of ETS, this smooth introduction can translate to a weaker emission target in the early stages. Governments can start ETS with a relatively easy emission target and increase its stringency in later stages. This approach is taken in many Asian ETS such as the Korean ETS and the Tokyo/Saitama ETS.

In the case of ETS, price stability is also crucial because of two reasons. First, if the price is not stable, industries cannot make investments of low carbon technologies with long-term perspective. Industries cannot have confidence in the return from the investment with highly fluctuating permit prices. Second, if the price is not stable, the revenue form permit auction cannot be easily predicted. In this case, it is not easy for governments to make long-term planning of policy.

To avoid these issues, economists have considered several options and governments have adopted them. To avoid the sharp increase of permit price, many ETSs have introduced a system of "Safety Valve", which limits the price level. In other cases, permit price may become too low as in the early stage of RGGI because of economic downturns. In this case, ETS may not be effective in promoting investment in low carbon technologies. One way to address this issue is to set the floor price. RGGI has adopted this system and worked in the auction of early years. EU ETS also suffered from low permit price after the financial crisis in 2007 and 2008. To solve the issue, a system of market reserve board was adopted in 2019 and reduced the supply of permits. After the introduction of this system, the permit price increased successfully.

F. Liquidity of Permits in Emissions Trading Schemes

Another issue associated with ETS is permit liquidity. For ETS to signal "right" price of carbon or pollution, the market of permits must have enough participants. However, in some ETSs, we observe the limited number of participants or transactions, and hence the liquidity of permits is limited in this case. Asian ETSs are no exceptions.

The KETS makes efforts to improve market liquidity. In the KETS, market participants trade emission allowances on the permit-trading platform, operated by the Korea Exchange. The trading is mainly conducted in Korean Allowance Units, with one Korean Allowance Unit equivalent to 1 tCO_2e. The allowances issued and traded in the market are recorded and managed through the Emissions Trading Registry System and the Offset Registry System. In the first phase, only companies that are registered with the KETS and are covered by the emissions cap can open allowance trading account and trade in the platform. This limits the basis of market participants. To encourage trading and lower transactions costs, some measures were introduced in 2016, including auction allowances of 900,000 tCO_2e from the reserve fund, lifting borrowing limits, and introducing offset carbon credits. These measures help boost trading by the end of the first phase. To further facilitate trading and improve market liquidity, the market maker system was introduced in the second phase, with financial institutions such as the Korea

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[9] We must mention that there may be backlash against carbon taxes, even when the tax increase is gradual (e.g., Yellow Jackets movement in France).

Development Bank, the Export–Import Bank of Korea, and the Industrial Bank of Korea serving as market makers. To further broaden market participants basis, financial intermediaries are able to trade allowances and carbon offsets on the Korea Exchange in Phase 3. During 2020, the average allowance price in the secondary market was W32,595.83/tCO_2e (or US$27.62/t$CO_2$e).

The KETS faced a few challenges during the implementation that can bring some experience for other markets. During its early years of implementation, the market operation was hindered by low liquidity and high transaction costs, partly because of limited number of market participants, a concentration of participants among a few corporate groups. The KETS effectively adopted some measures to improve liquidity. Close communication with industry and the gradual implementation also minimized possible shocks to the businesses.

As mentioned earlier, pilot ETS in India follows a combination of grandfathering as well as auctioning. To enhance market liquidity in pilot ETS in India, the weekly price of permits is determined via bidding at the uniform auction that takes place every Tuesday. Participation in this uniform auction is mandatory for all the compliant industries to facilitate the transparency. The permits are traded on that determined price from Wednesday to Monday following the day of uniform auction in the 'continuous market' (GPCB 2020). Further, it is mandatory for each compliant industry to appoint nodal representative who will be the point of contact with the Surat Regional Office and the NeML for auction participation and trading (GPCB 2020).

Other Asian ETSs also faced a similar liquidity problem, such as the Chinese pilot ETSs and the Japanese ETSs in Tokyo and Saitama.

G. International Dimensions

Expanding the scope of the market can contribute to lowering the cost of emission abatement. In this context, we can point out that linking domestic ETSs across Asia can help countries to achieve their emission-reduction target at a lower cost. Now that the ROK, the PRC, and Japan have domestic ETSs in each country, linking the ETSs in these countries is one option. However, the prices of emission credits in these markets differ. Moreover, the type of the participants in the markets differ across countries: in the PRC, financial intermediaries play important roles while only bilateral trades across the regulated facilities are allowed in Tokyo ETS. Therefore, some efforts are needed regarding rules before linking these ETSs in Asia.

Other applications of ETSs in the international dimension is the JCM run by the Government of Japan (Sugino et al. 2017). In this scheme, Japanese firms invest in partner countries to reduce GHG emissions. The Government of Japan and the host country can earn emission reduction credits. This is a type of international ETSs and similar to CDM under the Kyoto Protocol. A major difference is that energy-efficient projects can be approved more in the JCM than in CDM. Since the JCM is approved under the Paris Agreement, other Asian countries can adopt this scheme and earn international emission credits.

V. PRICE ELASTICITY AND THE EFFECTIVENESS OF POLICY INSTRUMENTS

Fiscal measures, including the carbon (and fuel taxes) on fossil fuels, will directly affect prices. In other words, the cost of consuming fossil fuel and related products will become expensive, thus helping governments to reduce GHG emission. However, it is crucial for policymakers to understand whether agents are responding to such policy or not. The consumers' responsiveness to such policy can be examined by price elasticity of fossil fuels. While there could be a number of reasons for selecting the specific rate for fossil fuels, a low tax rate will not change consumption behavior while a high tax rate will reduce household welfare. At the same time, consumers' response to price will be also dependent on overall economic situation and the prices of substitutes. Therefore, the ability of governments to adjust the carbon tax based on how consumers are responding to post-implementation prices will determine largely whether the objective of raising green revenue as well as reducing GHG emissions can be achieved.

Empirical studies that examine the price elasticity of fossil fuels (gasoline, gas, coal, and oil) suggest that price elasticities are small and inelastic in the short run while long-run elasticity is large and elastic. However, not all the studies report the short- and long-run elasticities, and there are variations in the analysis method as well as data used. Further, in majority of the studies, elasticities are computed by controlling for income and the price of substitutes. Table 6 illustrates a variety of findings on the size of price elasticities from empirical studies.

Evidence from United States suggests that gasoline price elasticity was between -0.21 and -0.75 during the period 1975–1980 while the price elasticity during period 2001–2006 had decreased to -0.034 – -0.077 (Hughes et al. 2008). This reduction was largely driven by the economic boom and the reduction on gasoline taxes in real terms. However, the price elasticity of gasoline increased from -0.05 in 2009 to -0.291 in 2017 (Goetzke et al. 2021) in the United States. Authors ascribe this phenomenon to 2008 global financial crisis, which was a primary source of shock in household income as well as the gasoline prices itself. Similarly, inelastic price elasticities are reported from other countries. Gasoline price elasticities in the PRC using province-year level was between -0.196 and -0.497, which is relatively higher than the United States. Similarly, study by Koshal et al. (2007) reports the short-run price elasticity of gasoline of -0.17 and long-run price elasticity -0.411, suggesting that demand for gasoline is inelastic. In India, the short- and long-run price elasticity of gasoline was reported at -0.17 and -2.08, respectively (Kanjilal and Ghosh 2018), suggesting inelasticity in the short run and elasticity in the long run. Arzaghi et al. (2015) examine the price elasticity using data from 32 countries from 1998 to 2010 that currently provides subsidy on fossil fuels and reports that price elasticity of -0.05 and -0.25 in the short and the long run, respectively. This suggests that demand for gasoline will be inelastic in the long run if the price or tax is too low.

One of the primary sources of emission are electricity plants, as current electricity portfolio is dominated by fossil fuels. Therefore, the carbon taxes will also affect the prices of electricity and, hence, it is important to know the price elasticity of electricity (besides household response to non-price interventions). The price elasticity of electricity varies substantially by the data used, method, and by region with one common feature of low price elasticity or inelastic demand in the short run. A study by Dergiades et al. (2008) using time data from 1965 to 2006 reports short-run price elasticity of -0.386 and long-run price elasticity of -1.06. On the other hand, Alberini et al. (2011) report price elasticity of -0.67 –

-0.87 using households level data from 1997 to 2007, while study by Ito (2014) reports the price elasticity of -0.03 – -0.05 using monthly consumption data from 1999 to 2007. Similarly, the study by Chindarkar (2019) reports the price of elasticity of electricity of -0.39 in India while Zhang et al. (2017) did find evidence of households responding to price when marginal price increased by 8%, but when price increased by 40% consumption reduced by 35% in Guandong province in the PRC. In South Australia, Fan et al. (2011) report the price elasticity of electricity demand between -0.363 and -0.428 and Bernard et al. (2011) report the short- and long-run price elasticity of -0.51 and -1.32 respectively. Overall, these evidences suggest that in the short run, the price elasticity of demand for electricity is inelastic, but elastic in the long run.

Zeng et al. (2018) estimate the price elasticity of gas in the PRC using 2014 household level data and price elasticity is -0.898, while a study by Yu et al. (2014) using panel data from 2006 and 2009 reports the price elasticity of -1.43. This suggests that the price elasticity of gas in the PRC is elastic. Similarly in the United States, Payne et al. (2011) estimate price elasticity of gas using time series data from 1970 to 2007 and short- and long- run price elasticity of gas is -0.185 and -0.264, respectively. However, using household level panel data from 1997 to 2007, price elasticity of gas is between -0.565 and -0.693, suggesting relatively inelastic demand. Rehdanz (2007) estimates price elasticity of gas in Germany using panel data from 1998 and 2003, and reports price elasticity of -0.44 – -0.63 while Meier and Rehdanz (2010) report the price elasticity of gas of -0.34 – -0.56 from the United Kingdom. Similarly, Yoo et al. (2009) estimate the price elasticity of -0.226 – -0.24 in the ROK. Overall results suggest that, except in the PRC, the demand for gas is inelastic.

However, evidence suggests that demand for oil in Germany is elastic while it is inelastic in the United Kingdom. Rehdanz estimates the price elasticity of oil in Germany of -0.168 – -2.03 while Meier and Rehdanz (2010) report the price elasticity of -0.40 – -0.49 in the United Kingdom. Further, the price elasticity of demand for coal in the PRC was elastic after 2008 but not before. For instance, Burke and Liao (2015) find no evidence of significant price elasticity before 2008, but the price elasticity of coal in 2012 is -0.44 and significant.

From above studies that examine the elasticity of fossil fuels (and electricity), short-run price elasticities are relatively small while price elasticities in the long run are large (or elastic). This finding suggests that, in the short run, fossil fuel consumption may not change, hence governments have potential to raise green revenue from carbon tax. In the short run, households and firms may not be able to respond to policy change because households and firms may require sufficient time and resources for planning their consumption under a new tax environment; for instance, changing conventional car to electric or fuel cell vehicles. Hence, households' welfare may reduce in the short run because of higher price resulting from carbon or fuel taxes, suggesting the need for the comprehensive plan for rebate or revenue recycling policy. However, there is no agreement on optimal rebate system. Economists that do not favor earmarking argue that revenues from carbon or environmental tax should be deposited into government's general account and should compete on equal footing for the fund. Hence, earmarking is often viewed as constraint for an optimization of government tax revenues. On the other hand, economists that favor earmarking argue that environmental or carbon taxes affect subset of population, and such proceeds should be spent to benefit the group affected by the policy. However, earmarking is viewed as the second best alternative optimal rebate structure. Current practices across globe suggests that earmarking is common practices. For instance, in Japan, fuel tax is earmarked for road maintenance and improvement, sulfur tax in France is earmarked for abatement investment (by polluting firms), and carbon tax in

Singapore is earmarked for environmental activities. The earmark strategy can potentially overcome political constrains or opposition from the affected group.

However, green revenue raising policy instruments may reduce household welfare. Therefore, comprehensive revenue recycling policy may play a critical role in terms of maintaining household welfare at pre-tax period. On the other hand, studies that report long -price elasticities suggest that the price elasticity of demand for fossil fuels (and electricity) are elastic in the long run. This is an indication that, in the long run, green revenue from carbon tax may decrease. Further, in the long run, environmental objectives may be achieved based on the evidence on elasticity of fossil fuels. This may encourage governments to withdraw green policies (including carbon tax, environmental taxes, or cap and trade programs.). However, it is important for policy makers to understand that, once such green taxes are removed, the dirty and polluting goods may become more competitive compared to goods and services produced using green inputs. Hence, withdrawal of such green policy will deteriorate the environment. Therefore, it is important that green policies be continued after achieving the objectives of the green policies.

Table 6: Price Elasticity by Fossil Fuel Type

Sl#	Author	Journal	Country	Data Type	Data Period	Elasticity
Panel A: Gas						
1	Alberini et al.	Energy Economics	US	Panel	1997–2007	-0.565 – -0.693
2	Payne et al.	Regional Policy and Analysis	US	Time series	1970–2007	-0.185 (SR) -0.264 (LR)
3	Rehdanz	Energy Economics	Germany	Panel	1998 and 2003	-0.44 – -0.63
4	Meier and Rehdanz	Energy Economics	Britain	Panel	1991–2005	-0.34 – -0.56
5	Yu et al.	Energy Policy	PRC	Panel	2006–2009	-1.43
6	Zeng et al.	Journal of Cleaner Production	PRC	Cross section	2014	-0.898
7	Yoo et al.	Applied Energy	ROK	Cross section	2005	-0.226 – -0.264
Panel B: Gasoline						
1	Goetzke et al.	Energy Economics	US	Pooled cross section	2009–2017	-0.05 (in 2009) -0.291 (in 2017)
2	Hughes et al.	Energy Journal	US	Time series	1975–1980 and 2001–2006	-0.034 to -0.077 (2001 to 2006, SR) -0.21 to -0.75 (1975 to 1980, SR)
3	Lin et al.	Energy Policy	PRC	Time series	1997–2008	-0.196 – -0.497
4	Koshal et al.	International Journal of Transport Economics	Japan	Time series	1957–1999	-0.115 (SR) -0.411 (LR)
5	Kanjilal and Ghosh	Empirical Economics	India	Time series	1971–2013	-0.17 – -0.26 (SR) -2.08 (LR)

Sl#	Author	Journal	Country	Data Type	Data Period	Elasticity
6	Arzaghi et al.	Energy Economics	32 countries	Times series	1998–2010	-0.05 (SR) -0.25 (LR)
Panel C: Electricity						
1	Ito	American Economic Review	US	Panel	1999 to 2007	-0.03 – -0.05
2	Dergiades et al.	Energy Economics	US	Time series	1965 to 2006	-0.386 (SR) -1.06 (LR)
3	Alberini et al.	Energy Economics	US	Pooled cross section	1997 to 2007	-0.67 – -0.87
4	Zhang et al.	Energy Policy	PRC	Panel	2011 and 2012	Insignificant when marginal price increased by 8%. Consumption reduced by 35% when price increased by 40%.
5	Bernard et al.	Energy Economics	Canada	Pooled cross section	1989, 1994, 1999 and 2002	-0.51 (SR) -1.32 (LR)
6	Fan et al.	Energy Policy	Australia	Time series	1997–2008	-0.363 – -0.428
7	Chindarkar et al.	Energy Economics	India	Time series	2005–2012	-0.39
Panel D: Oil and Coal						
1	Burke and	China Economic Review	PRC	Panel (fuel: coal)	1998–2012	Price elasticity of coal before 2008 is not significant, but price elasticity in 2012 is -0.44 and significant.
2	Rehdanz	Energy Economics	Germany	Panel (fuel: oil)	1998 and 2003	-1.68 – -2.03
3	Meier and Rehdanz	Energy Economics	UK	Panel (fuel: oil)	1991–2005	-0.40 – -0.49

LR = long-run, PRC = People's Republic of China, ROK = Republic of Korea, SR = short run, UK = United Kingdom, US = United States.

Note: In this review, electricity is not fossil but reported as fossil fuels that are used for generating electricity. The 32 countries of Arzaghi et al. include mostly oil-exporting countries.

Source: Authors.

VI. POLICY IMPLICATIONS

There are several take home messages from the discussion in our paper. First, revenue-raising green policy instruments can reduce emissions. Even if the impact on the emission reduction in the short term is limited, it can have decent effects in the long run. Thus, to address their local pollution problems and the global climate change issue, Asian governments should consider the introduction of these policy instruments for environmental conservation.

Second, with environmental tax or ETSs, governments can raise revenue. These environmental policy instruments can assist government financially though the size of the revenue may be limited. Thus, governments should consider these policy instruments as important options for their budget.

Third, it is important to carefully consider how to use the revenue generated from these instruments. If a government focuses on emission reductions, the revenue could be earmarked and used for the promotion of low carbon/pollution technologies such as energy efficiency or renewable energy. Alternatively, if a government wants to focus on economic growth, the revenue could be used to decrease corporate taxes to promote economic growth. Finally, governments can use it as additional revenue for the general budget.

Fourth, even with tax rebates, one must still understand that carbon taxes affect energy prices as a whole, and may have a distortionary effect on the economy. Still, governments can mitigate the shock to economic activities in several ways. In the case of a tax, governments can start with an initial rate at a low level and increase it gradually. Moreover, governments can achieve this objective through exemptions for heavily affected sectors such as energy-intensive industries, at least in the initial phases. In the case of ETSs, governments can allocate permits freely to emitters and could begin with an ETS with a weak emission target. Moreover, in ETSs, SMEs can be exempted from the regulation as in the PRC, the ROK, or Japan.

Fifth, MRV is an important base for green revenue policy instruments. Developed economies can assist developing countries to install monitoring equipment both financially and technically, with capacity building. We can point out that, in contrast to tax, ETS may need more capacity building in the government sector because of the importance of the MRV process.

The policies discussed in this paper is promising. However, given the size of the underlying problems, the current scale and scope of these policies are limited. Therefore, governments should accelerate the introduction of these policies and its scope. Further, carbon/environmental tax or ETS alone cannot solve the environmental problems Asian countries are facing. Thus, Asian countries must implement other complimentary policies to address the issues. For example, energy efficiency standard of electric appliances is implemented in European countries, North America, and some Asian economies. Renewable energy has been promoted by feed-in tariff in European Union countries and renewable portfolio standard in the United States. Thus, governments should consider these complementary policies together with green revenue-raising policy instruments for environmental conservations.

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