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REVIEW

Reconciling the flexibility mechanisms of climate policies towards the inclusiveness of developing countries: commitments and prospects

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Abstract
The Kyoto Protocol, signed in 1997 and enforced in 2005, aimed to reduce global emissions and establish three mechanisms: an emission trading system, a clean development mechanism, and a joint implantation mechanism. The transition from the Kyoto Protocol to the Paris Agreement requires a better understanding of the modalities, procedures, and accomplishments. This study examines the related commitments and achievements in the context of the legal framework, efficiency, carbon price, and the parties and sectors involved; it also draws implications for developing countries. Global emissions increased over the year despite commitments by Annex I members. Middle-income developing countries were largely responsible for this increase. Low-income developing countries could not fully benefit from the clean development mechanism due to insufficient access and implementation capacity. According to the data reported, most of the beneficiary host countries are in the category of middle-income countries (94%), while low-income countries account for only 2% of the related projects hosted, although they represent around 15% of the total countries. The transition to the Paris Agreement must involve a clear definition of the modalities, procedures, and certain enforcement elements for cases of non-compliance. The current experience of related parties, such as the European Union Emissions Trading Scheme and other flexibility mechanisms, has several implications for the developing world in terms of legal frameworks, efficiency, capacity building, the role of agriculture, and regional collaboration to address climate change.

Keywords Carbon emissions · Climate change · Flexibility mechanisms · Developing countries

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1 Introduction

The Kyoto Protocol, signed in 1997 and enforced in 2005, set forth three main flexibility mechanisms: international emissions trading (ET), a clean development mechanism (CDM), and joint implementation (JI). The parties with commitments (Annex B countries; the EU, Australia, Iceland, Kazakhstan, Liechtenstein, Monaco, Norway, Switzerland, Ukraine) agreed to limit or reduce emissions (UNFCCC, 2019a). Annex B countries committed to certain emission reductions or limits. The first commitment period covered 2008–2012, and 38 industrialized countries committed to reducing their emissions by 5% compared to 1990 levels. However, some countries, such as members of the EU, opted for greater reductions (European Environment Agency [EEA], 2019). The second commitment period initiated in Doha in 2012 covered the period 2013–2020 and aimed for reductions of 18% for Annex B countries from the base period (UNFCCC, 2019b). The Paris Agreement, signed in 2016 as a post-Kyoto agreement, introduced the Sustainable Development Mechanism, Article 6, whereby all related parties were to achieve the goal of decreased global warming, parties were permitted to use international emissions trading, and new market and non-market mechanisms were to be supported (UNFCCC, 2019c). The Paris Agreement introduced nationally determined contributions (NDCs), enabling each member country to reduce national emissions and employ adaptation and mitigation strategies for climate change. Progress is checked through regular global stocktake.

The related mechanisms of climate change policies were examined in the context of various dynamics in some studies such as related policy incentives towards technology transfer (Millock, 2002), the leadership of regional blocs (Gupta & Ringius, 2001), the influence of non-governmental organizations (NGOs) (Gulbrandsen & Andresen, 2004), the importance of social networking (Stein, 2008), emerging institutions (Kolk & Pinkse, 2008), and legal strategies for adaptive management (McDonald & Styles, 2014). Several studies have examined the experiences of the Kyoto Protocol and the interaction among developing countries. These studies have researched the quantification of the ex-post emission mitigation impacts (Kuriyama & Abe, 2018), the efficiency aspects of the European Union Emissions Trading Scheme (EU ETS) (Klaassen et al., 2005; Montagloni & de Vries, 2012), Asia ETS (Massetti & Tavoni, 2012), compliance for the first commitment period (Shislov et al., 2016), carbon markets in developing countries (Turhan & Gundogan, 2019; Wang et al., 2019; Zheng & Zhu, 2019), and the CDM and access issues confronting developing countries (Andonova & Sun, 2019; Castro & Michaelowa, 2011; Dirix et al., 2016; Fay et al., 2011).

Given that the Paris Agreement will replace the Protocol in 2020, it is essential to better understand the outcomes of the mechanisms implemented and the implications for developing countries. World carbon emissions tend to increase, and developing countries account for most of the increase (World Bank, 2019a). Global participation in climate agreements and related commitments is essential to deal with climate change. However, most of the time, developing countries lack adequate tools and the technical capacity to alleviate the negative impacts of climate change. In this stage, two important factors arise: whether the commitments by developed countries are realized, and whether the lessons learned from the implementation of flexibility mechanisms can contribute to the policy design of developing countries. Therefore, this study first aims to examine the current mechanisms implemented in the context of emissions, commitments, achievements, foreign direct investment (FDI) outflow in polluting sectors, current issues such as the legal framework, and the efficiency of mechanisms based on the most recent data, and then draws the implications for

developing countries. Many other studies have examined the flexibility mechanisms in the context of single dynamics (pricing, efficiency, legal framework, etc.) or covering certain countries. The contribution of this study is twofold. It investigates the current status of emission achievements based on commitment and examines various aspects of the mechanisms comparatively utilizing the most recent data in order to monitor the efficiency of these mechanisms.

This study first examines the commitments of the related parties and their current status utilizing related international data. Then, we examine associated dynamics, such as FDI, in the context of major pollutants. The rest of the study investigates the implementation and consequences of flexibility mechanisms, comparatively utilizing the UNEP database (2019), and draws implications for developing countries based on the data available.

2 Emissions and Kyoto commitment

There are currently 192 parties in the Protocol, but only 36 Annex B countries have current specific official commitments (UNFCCC, 2019a). Total CO_2 emissions by related parties are presented in Fig. 1. The data show that world emissions increased over the years, reaching around 38 Gt in 2018. The emissions of the EU and non-EU Annex I countries decreased or remained stable, while those of the rest of the world (ROW) increased (Fig. 1). In addition, the shares of the EU and non-EU Annex I countries in total emissions also decreased (Fig. 2).

The Kyoto Protocol covers two commitment periods for Annex B counties. Under the Kyoto Protocol, base year emissions are defined as the aggregate anthropogenic CO_2 equivalent of greenhouse gas emissions (GHGs). The first commitment period covers 2008–2012 with a cap or reduction of 5% from the base period of 1990. The second commitment period signed in 2012 covers the 2013–2020 period. Most base years are 1990, but countries transitioning to a market economy may choose a year or period other than 1990 in accordance with Article 3 of the Protocol. The related Annex B countries and their commitments are listed in Table 1. Canada withdrew from the protocol in 2012, the USA did

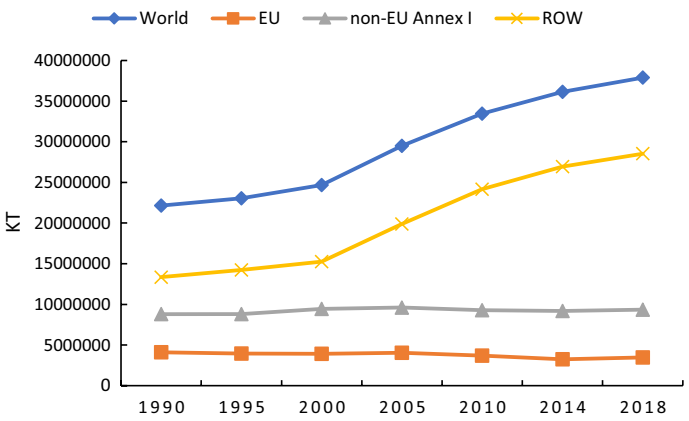

Fig. 1 Total CO_2 emissions by parties, 1990–2018. *Source*: World Bank (2019a) (1990–2014); Crippa et al. (2019) (year 2018)

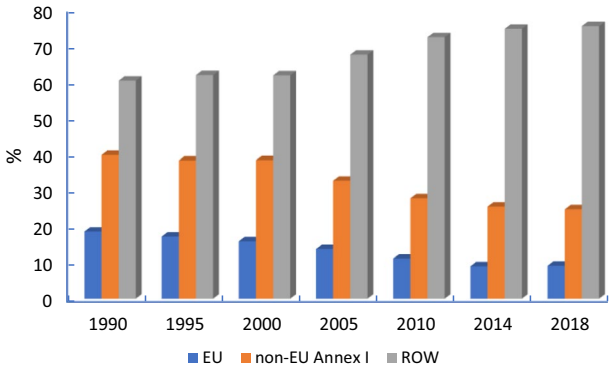

Fig. 2 The share of related parties of total CO_2 emissions, 1990–2018. *Source*: Calculated using World Bank (2019a) data

not ratify it, and Russia, Japan, and New Zealand did not set commitments for the second period (UNFCCC, 2019a).

The world's total GHG emissions reached around 49 Gt CO_2 equivalent in 2015, an increase of approximately 53% from the base year, 1990 (Crippa et al., 2019). According to the data, total GHG emissions in 2017 decreased in the EU, Australia, Kazakhstan, Russia, Switzerland, and Ukraine. The highest decrease occurred in Ukraine (56%) followed by Russia and the EU. On the other hand, GHG emissions increased in Canada, Japan, Norway, New Zealand, and the USA. The highest increase occurred in New Zealand (30.59%) followed by Canada (20.5%). CO_2 emissions increased in Australia, Canada, Japan, Kazakhstan, Norway, New Zealand, and the USA. The highest increase among Annex B countries occurred in Australia (58.15%) followed by New Zealand and Canada.

On the other hand, the world's largest CO_2 emitters are shown in Figs. 3 and 4. World total CO_2 emissions increased by 71% in 2018 from the 1990 level. In total emissions, China ranks first followed by the USA, India, Russia, and Japan. China and India increased their share of the world's total while others decreased their share. China's total CO_2 emissions quintupled, whereas India's total CO_2 emissions quadrupled in that period.

The CO_2 emissions of selected developing countries by region are presented in Fig. 5. As can be seen, emissions of certain developing countries such as Indonesia, Malaysia, Philippines, Thailand, Pakistan, Mexico, and Brazil increased significantly over the period examined.

3 Foreign direct investment and emissions

Whether FDI causes pollution havens in developing countries due to lax regulations or improvements due to cleaner technologies is a subject of discussion. Overall, the EU is close to accomplishing its commitments in terms of total GHG emissions as presented in the data. Therefore, one question is whether the EU's accomplishment is due to increasing FDI outflow to developing countries in polluting sectors. For this purpose, based on data availability, we examine the EU's FDI outflow into China, the world's number one polluter. To obtain a consistent comparison, the FDI data are classified as the 2003–2007 average as the base period, and the 2008–2013 average as the period for the first commitment. Table 2 shows the EU's FDI outflow in major polluting sectors (refined petroleum, chemical products, rubber and plastic products, and metal products) based on the Organization

Table 1 Annex B commitments, 2008–2020, and recent achievements

Major Annex B members with commitments	Base year total GHG emissions, CO_2 equivalent, KT, 1990[a]	Achievements, latest total GHG emissions, CO_2 equivalent KT, 2017[b]	Change, %	Targets for the first commitment period [2008–2012] [based on 1990%][a]	Targets for the second commitment period [2013–2020], %[a]	CO_2 emissions, KT, 1990[c]	Achievements, latest CO_2 emissions, KT, 2017[b]	Change %
EU	5,875,693	4,323,163	−26.42	−8	−20	4,100,786	3,515,490	−14.27
Australia	566,786	554,126	−2.23	+8	−0.5	263,704	417,041	58.15
Canada**	593,998	715,749	20.50	−6	–	435,181	571,138	31.24
Japan	1,261,331	1,289,630	2.24	−6	–	1,096,179	1,188,122	8.39
Kazakhstan	371,295	365,000[c]	−1.70	–	−5	262,043	309,000[c]	17.92
Norway	51,922	52,712	1.52	+1	−16	31,510	43,702	38.69
New Zealand	61,913	80,853	30.59	0	–	23,545	36,023	53.00
Russia	3,323,419	2,155,470	−35.14	0	–	2,078,668	1,647,041	−20.76
Switzerland	53,707	47,158	−12.19	−8	−15.8	42,610	38,171	−10.42
Ukraine	937,954	411,000[c]	−56.18	0	−24	630,929	195,000[c]	−69.09
USA***	6,136,093	6,456,718	5.23	−7	–	4,823,403	5,270,748	9.27

**Withdrew in 2012

***Did not ratify. For some countries the target information is not available/no target set

[a]UNFCCC (2019a)

[b]OECD (2019a)

[c]World Bank (2019a)

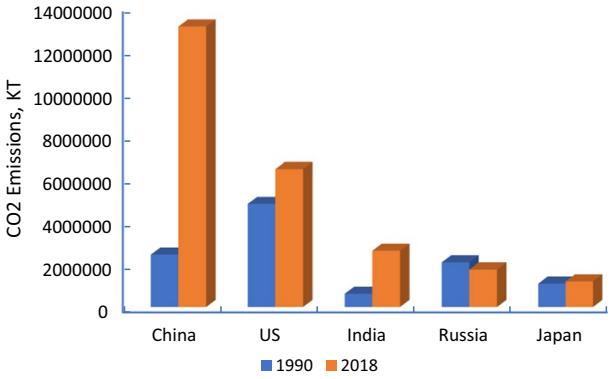

Fig. 3 Largest CO_2 emitters, kt, 1990–2018. *Source*: World Bank (2019a), Crippa et al. (2019)

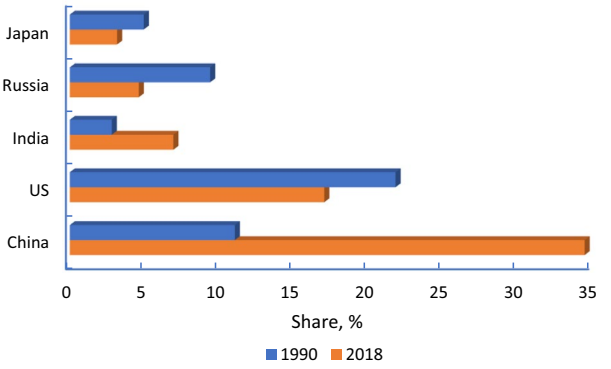

Fig. 4 Largest CO_2 emitters, kt, share of total CO_2 emissions, 1990–2018. *Source*: World Bank (2019a), Crippa et al. (2019)

for Economic Co-operation and Development (OECD) classification (OECD, 2019b). In general, the EU's total FDI outflow in polluting sectors decreased by almost 50% between 2008 and 2013, on average, compared to 2003–2007. Most of the members' outflow displayed a decreasing trend except Austria, Belgium, Finland, and Germany. In general, average FDI outflow from the EU to China in polluting sectors decreased by almost 50%.

Total FDI outflow from Annex B to China (Table 3) varied but, overall, outflow increased from France (almost eight times) and Italy (10 times), while it decreased from the Netherlands. The USA decreased its outflow slightly (OECD, 2019b). The major EU partners, Japan and the USA, accounted for 14% of FDI outflow to China in the 2003–2007 period, while this ratio decreased to 8.67% from 2008 to 2013. Unfortunately, there is no consistent data set for bilateral trade flow in specific sectors. However, the ITC (2019) data (Table 4) displays bilateral FDI outflow on a firm basis. Based on this data, 25% of the 31,967 foreign affiliates are related to the polluting sectors. This shows that most of the pollution originates from domestic producers in China. In terms of trade flow, the value of these polluting sectors represented approximately 400 billion USD or 17% of China's total exports in 2015 (ITC, 2019; World Bank, 2019a).

There is a limited body of literature examining the impact of FDI on the Chinese economy in terms of emissions. While Bao et al. (2011) found that FDI helps to reduce emissions in China due to technical effects, Lin and Sun (2016) found evidence of a pollution haven caused by varying regulations at the provincial level. Trade flow also affects

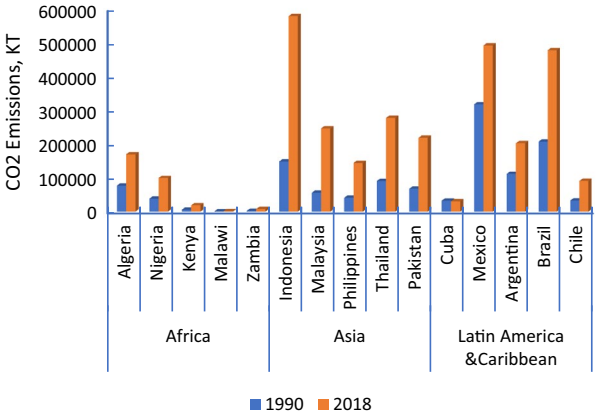

Fig. 5 CO_2 emissions in selected developing countries by region, kt, 1990–2018. *Source*: World Bank (2019a), Crippa et al. (2019)

Table 2 The EU's average FDI outflow to the World in polluting sectors, million euro, 2003–2013. *Source*: Calculated from OECD (2019b)

Members	2003–2007 Average	2008–2013 Average
Austria	330	420
Belgium	1351	4157
Denmark	2794	1487
Finland	325	1046
France	3150	1060
Germany	311	1208
Greece	86	− 14
Ireland	709	− 265
Italy	2124	549
Luxembourg	15,283	880
Netherlands	24,225	16,840
Spain	1644	1050
Sweden	31,411	13,118
UK	4799	4463

Table 3 Major Annex B Countries' FDI outflow to China, million euro, 2003–2013. *Source*: OECD (2019b)

Partner country	FDI outflow, average value [2003–2007]	FDI outflow, average value [2008–2013]
France	550	2486
Germany	1976	4940
Italy	193	1282
Netherlands	278	477
UK	592	730
USA (USD)	3439	1862
JP (USD)	5491	7801
World total outflow, China (USD)*	88.000	226.000

*World Bank (2019a)

Table 4 Foreign affiliates in China and polluting sectors. *Source*: ITC (2019)

Number of foreign affiliates in China	2015	Share in total foreign affiliates
Coke, petroleum products	605	1.89
Chemical products	2035	6.36
Rubber and plastic products	1720	5.38
Metal and metal products	3672	11.48
Sub-total	8032	25.11
Total number of foreign affiliates	31,967	

pollution. For instance, one study (Atici, 2012) found that China's imports from partner countries in South East Asia stimulate pollution in ASEAN members through overproduction and lax regulations.

4 EU emissions trading scheme and current issues

Article 17 of the Kyoto Protocol sets emissions trading, which allows countries to sell their excess capacities. The ETS can be established at the national or regional levels, and emissions obligations in that case must be set by the government. The EU ETS was established in 2005 in line with the Protocol. The EU ETS legislation enables EU ETS to link with other compatible emissions trading systems at the national or regional level, provided there is system compatibility and the existence of an absolute cap on emissions (EU, 2019a). The EU and Switzerland have signed an agreement to link their systems, which will enable the sharing of EU and Swiss emission allowances (EU, 2019b).

4.1 Legal framework

An EU report (EC, 2019) indicates that the approach for ETS allowances in member states differs, which causes certain legal uncertainties. The EU ETS is regulated by various directives (Directives 2003/87/EC and 2018/410/EU6 establishing a system for GHG emission allowance trading within the EU and Directive 2014/65/EU related to the markets in financial instruments (MiFID II)) (Eurlex, 2019). As mentioned in the report, Directive 2003/87/EC does not specify the legal nature of the traded allowances. The uncertainty surrounding the definition leads to various interpretations. For example, allowances are property, a right, or a financial instrument among the member states' legislation. Certainly, these differences may have a deterrent effect in constructing efficient markets. The EU has a transparent system of regulations (Eurlex, 2019), and audit reports related to issues arose from the implantation of the ETS and related recommendations (EU, 2020). The issues mentioned in these reports are reported as country-specific. Developing countries can benefit from the EU's experiences in setting out a legal framework to design carbon-pricing policies.

4.2 Pricing and efficiency

Carbon pricing is essential for capital flow, mobilizing knowledge, and reducing emissions. Basically, there are two mechanisms for carbon pricing: emissions trading and carbon tax. These mechanisms internalize the cost of a polluting environment by changing the behaviours of producers and consumers, stimulating innovation, generating environmental benefits, and providing government revenues (World Bank, 2019b). For the carbon tax system, the price is set by the government, and the markets are allowed to determine the quantity of emissions. For emissions trading systems, the government sets the quantity of emissions and allows the market to determine the price. There are also hybrid systems such as an ETS with a price floor and ceiling or a tax. The World Bank (2019b) sets six principles for successful pricing called FASTER (fairness, alignment of policies and objectives, stability and predictability, transparency, efficiency and cost effectiveness, reliability, and environmental integrity.)

In allocating emission allowances, various methods are used such as auctioning and free allocation. The EU ETS mainly uses auctioning while in other regions, such as China, free allocations are used (World Bank, 2019b). The EU ETS has certain problems such as over-allocation and price volatility. When the ETS was introduced in 2005, governments issued many permits for their local industries, causing higher caps for their base periods. Over time, variations in demand caused by companies investing in cleaner technologies and lower liquidity in secondary markets (EC, 2019) caused higher volatilities. For instance, the European Emission Allowance (EUA) auction price varied markedly (between €6.45 and €24.21) from 2012 to 2018 (European Energy Exchange [EEX], 2019).

The efficiency of the ETS and related issues have been addressed in a number of studies. Klaassen et al. (2005) test the theory of emissions trading based on experiments in the six largest industrial regions in the EU. The results imply that both auctions and bilateral sequential trading converge to market equilibrium. However, not all countries benefit from trade caused by imperfect market structures. Montagloni and de Vries (2012) measure the efficiency of the EU ETS employing the efficient market hypothesis (EMH). Their findings indicate that although the trial and learning period (Phase I) was inefficient, the next period (Phase II) implied the restoration of market efficiency.

5 Clean development mechanism

The CDM is a market-based approach that aims to reduce emissions through investments in developing countries. The mechanism enables Annex B countries to invest in emission–reduction projects in developing countries. These types of projects are qualified for certified emission reduction credits (CERs). Developed countries can buy CERs and use them to achieve their emission reduction targets under the Kyoto Protocol (UNFCCC, 2019d). According to the UNFCCC report (2018), there are 7803 registered projects covering 140 countries. Thirty-six of them are least developed countries (LDCs), leading to two billion tonnes of CO_2 reduction in the developing world. However, there has been some criticism of the mechanism. Access to formal international institutions and foreign aid (Andonova & Sun, 2019) and failing to alleviate poverty (Dirix et al., 2016) are the main concerns. Strong industrial and energy policy in a host country (Fay et al., 2011) plays a crucial role in the development of the CDM. The EU's

rule for special import quotas for CERs from the least developed countries may not be enough (Castro & Michaelowa, 2011) if the barriers for project implementation are not overcome. Certainly, these critiques should be part of the agenda for improvements in the related mechanisms.

The CDM projects with the CERs issued by sectors based on the UNEP database (Fenhann, 2019) are presented in Table 5, and the host country income levels are presented in Fig. 6. According to the data, most of the beneficiary host countries are in the category of middle-income countries (94%), while low-income countries account for only 2% of the CDM projects hosted, although they represent around 15% of the total countries. These data indicate that low-income countries could not fully benefit from the CDM projects due to a lack of technical capacity to access the mechanism. Another point to consider is that almost 70% of the projects are hosted by China and India alone.

Table 5 CDM projects with issued CERs, 2019. *Source*: UNEP-DTU Database (Fenhann, 2019)

Type	Projects	Issued kCERs	Issuance success, %
Afforestation	4	2349	66
Biomass energy	266	56,519	70
Cement	12	12,397	104
CO_2 usage	1	10	19
Coal	43	62,465	58
Energy distribution	6	2665	98
EE households	20	1760	32
EE industry	43	5159	63
EE own generation	167	82,266	77
EE service	5	229	48
EE supply side	20	8631	59
Fossil fuel switch	63	72,391	52
Fugitive	18	41,674	79
Geothermal	11	13,695	87
HFCs	19	539,942	108
Hydro	924	298,538	82
Landfill gas	168	117,479	51
Methane avoidance	261	33,789	62
Mixed renewable	2	40	56
N_2O	60	354,288	103
PFCs and SF6	9	8335	68
Reforestation	25	13,384	123
Solar	76	7852	86
Tidal	1	2220	94
Transport	12	5172	61
Wind	975	253,816	78
Total	3211	1,997,065	82.7

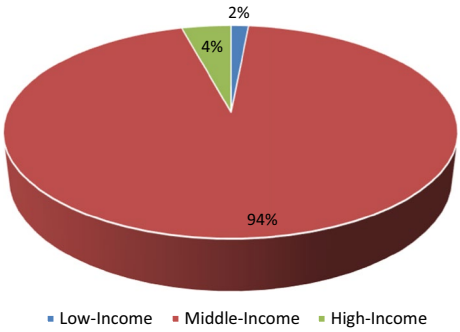

Fig. 6 CDM project host countries by income level. *Source*: Calculated utilizing the UNEP-DTU Database (Fenhann, 2019)

6 Joint implementation

Joint implementation is the mechanism outlined in Article 6 of the Kyoto Protocol. This mechanism enables a country with an emissions reduction or limitation commitment (Annex B Party) to earn emissions reduction units (ERUs) from an emissions reduction or emissions removal project in another Annex B Party. These units are equivalent to one tonne of CO_2 and can be counted to meet defined Kyoto targets. This mechanism provides related parties a flexible and cost-efficient means of fulfilling commitments. On the other hand, the host party benefits from this mechanism through foreign investment and technology transfer. This mechanism involves Track 1 and Track 2 procedures. If a host party meets all of the eligibility requirements to transfer and acquire ERUs, it may issue the appropriate quantity of ERUs upon verification. This procedure is referred to as the Track 1 procedure. If a host party does not meet all eligibility requirements, verification of emission reductions needs to be implemented through the verification procedure under the Joint Implementation Supervisory Committee (JISC). In this Track 2 procedure, an independent entity accredited by the JISC determines whether the relevant requirements were met in order for the host party to issue and transfer ERUs (UNFCCC, 2019d).

The UNEP database on the JI mechanism (Fenhann, 2019) displays the current status of the projects as shown in Table 6. There are 761 projects, 73% of which are listed in Track I, and the remaining 27% are listed in Track 2. The total amount of the ERUS issued is around 863 million. Ukraine ranks number one with 321 total projects followed by Russia (182), the Czech Republic (59), and Slovakia (50). As presented in the data, most of the JI projects are CH4 reduction projects covering (gas pipeline leaks) (40%) and energy efficiency (EE) improvements (29%) (Table 7). A World Bank study (Martin, 2000) indicates that a high concentration of EE projects in initially emission-intensive sectors might lead to an increase in the use of that energy leading to higher emissions. Therefore, long-term impacts of the JI projects should be considered for sustainable energy consumption.

7 Implications for developing countries

The implementation of the flexibility mechanisms has several implications for developing countries. Previous studies examining these mechanisms attempted to draw implications based on the findings of their studies. Anger (2008) examines the economic impacts of

Table 6 Number of joint implementation projects by country. *Source*: UNEP-DTU Database (Fenhann, 2019)

Host country JI projects	Track 1		Track 2		Total	
	Number of projects	Issued kERUs	Number of projects	Issued kERUs	Number of projects	Issued kERUs
Russia	96	264,658	86	520	182	265,177
Ukraine	250	506,551	71	10,185	321	516,736
Bulgaria	29	6851	9	98	38	6949
Czech Republic	58	607	1	0	59	607
Romania	17	4266	4	4672	21	8938
Poland	36	20,048	4	0	40	20,048
Hungary	11	7175	2	0	13	7175
Estonia	12	817	2	0	14	817
Latvia	1	0	0	0	1	0
Lithuania	0	0	20	8531	20	8531
Slovakia	0	0	2	0	2	0
Belgium	2	400	0	0	2	400
Germany	12	13,502	1	0	13	13,502
Finland	3	972	0	0	3	972
France	17	9183	0	0	17	9183
Greece	0	0	2	0	2	0
Spain	3	0	0	0	3	0
Sweden	0	0	2	1340	2	1340
New Zealand	8	3094	0	0	8	3094
Total	555	838,125	206	25,345	761	863,470

linking the EU emissions trading scheme (ETS) to emerging schemes beyond Europe using a multi-country equilibrium model of the global carbon market. The results indicate that linking the European ETS induces only minor economic benefits as trading is restricted to energy-intensive companies that are assigned high initial emissions. The major compliance burden is carried out by non-trading industries that are excluded from the linked ETS. The study suggests that to attain higher efficiency, future climate policy regimes with a joint trading system are needed to facilitate international emissions trading between ETS companies and post-Kyoto governments. In terms of developing markets, Massetti and Tavoni (2012) propose and assess a regional carbon trading scheme (Asia ETS) employing a global inter-temporal optimal growth model. Their findings claim that creating two large trading markets generates regional incentives and transfers. Choi and Lee (2016) examine the efficiency of company-level ETS in South Korea using a nonparametric directional distance function. The findings indicate that there is potential for participating companies to improve carbon-based technical efficiency (by around 53%), and there is strong substitutability between capital and energy. These findings imply that green technology investment may lead to a higher degree of energy-saving performance. Governments' price-oriented market intervention has led to insufficient sustainable performance due to low-carbon prices. The authors suggest an improvement in the governance factors of the ETS in terms of more effective green investment and easier access to green technology. Using policy

Table 7 Type and number of joint implementation projects, 2019. *Source*: UNEP-DTU Database (Fenhann, 2019)

Type	Number
Afforestation and reforestation	2
Agriculture	12
Biogas	8
Biomass energy	48
Cement	5
CO_2 capture	1
Coal bed/mine methane	33
Energy distribution	56
EE households	1
EE industry	103
EE own generation	7
EE service	14
EE supply side	37
Fossil fuel switch	24
Fugitive	172
Geothermal	5
HFCs	4
Hydro	27
Landfill gas	83
N_2O	55
PFCs	8
Solar	1
Tidal	0
Transport	4
Wind	50
Total	760

documents and expert interviews, Turhan and Gundogan (2019) claim that the carbon market in Turkey is an internationally driven process rather than a national interest. Smits (2017) identifies that the generation of domestic demand for carbon credits, building and maintaining human capacity and adequate data, creating space for civil society, ensuring coordination within the government and between sectors, and establishing further linkages with regional (Asian) and global carbon market mechanisms, such as those in China, Japan, and South Korea, are essential elements for future carbon market mechanisms. Zheng and Zhu (2019) employ the strategic behaviour of imperfect competition and find that firms will delay the adoption of new emission abatement technology in the presence of market power. Additionally, when output demand is more elastic, emissions abatement technology diffusion occurs earlier. Wang et al. (2019) list the main challenges for China's national emissions trading programme as a lack of institutional capacity, market volatility, and efficiency loss due to state-owned enterprises (SOEs). Hu et al. (2020) examine the energy conservation and emission reduction effects of China's CO_2 ETS pilot policy implemented in 2011. Using panel data at the provincial level from 2005 to 2015, their findings show that the CO_2 ETS decreases the energy consumption of the regulated industries in pilot areas by 22.8% and the CO_2 emissions by 15.5% compared to those in non-pilot areas. The authors also found that the policy effects are driven mainly by improved

technical efficiency and adjustments in industrial structure, and the ETS performs better in areas with high levels of environmental enforcement and marketization.

The inclusion of agriculture in ETSs is another subject of discussion. Agriculture accounts for a high share (up to 60%) of GDP in many developing countries (World Bank, 2019a). Agriculture-led CO_2 emissions account for 1.24% of total emissions (IEA, 2019). However, in terms of total GHG, emissions share an increase of approximately 9% (FAOSTAT, 2019) due to emissions of methane (livestock activities), nitrous oxide (fertilizers and waste), and expansion of total agricultural outputs mainly in developing countries (FAO, 2019). EU agriculture accounts for 10% of total GHG emissions (Eurostat, 2019). The inclusion of agriculture in ETS has caused some debate. For instance, Ancev (2011) claims that transaction costs will be high, and implementation will not be socially beneficial. The author recommends voluntary participation instead of mandatory participation. On the other hand, De Cara and Vermont (2011) claim that, at least for the EU, transaction costs can be lowered to benefit the sector by setting lower limits and encouraging participation through industry associations.

Based on the related literature and the current available data of this study, several implications can be drawn for developing countries. A well-designed legal framework covering clear definitions, related parties, and enforcement are essential in introducing and implementing an ET scheme. In terms of pricing, establishing well-functioning financial markets and adequate pricing is essential for developing countries aiming to deal with emission mitigation policies. A World Bank report (2019b) estimates that there are 57 carbon-pricing initiatives implemented globally; however, the amount of carbon emissions covered by carbon pricing and price levels is not enough to meet the objectives of the Paris Agreement. According to the report, only 20% of the greenhouse emissions are covered by global initiatives and only 5% of them have price levels in line with the estimates for achieving the goals of the related Agreement, between $50 and $100 by 2030. The report highlights that international collaboration towards interregional ETS, linking national markets for greater depth and liquidity, implicit carbon price policies such as carbon tax and the elimination of fossil fuel subsidies, and private sector involvement by using carbon pricing in financial decisions are crucial for efficient carbon pricing globally. Definitely not all developing countries are homogenous. The implantation of the CDM as mentioned earlier highlights that most of the projects are shared by a few developing countries, causing LDCs to underperform. This finding underlines the development of capacity towards more active inclusion of LDCs. Some of Annex I parties in JI is the lower-middle-income group (World Bank, 2020) or classified as economies in transition (UN, 2020), which account for most of the JI projects in the area of energy efficiency. The high share of energy efficiency projects in JI also emphasizes the direction of future collaboration areas in a global setting and helps determine priority areas when funds are scarce. The flexibility mechanisms can serve as a tool for technology transfer to host developing countries. However, there is still potential for further widespread use, such as lowering the cost (Youngman et al., 2007) associated with producing greener energy. In addition, subsidized technology transfer may hurt the industries in host countries (Forsyth, 1999), which requires careful governance.

Certainly, the inclusion of the agricultural sector will be the subject of discussion for future climate change agendas. Developing countries face a few problems, such as insufficient capacity for technical infrastructure, related inventory, and organization of the financial markets. These issues should be addressed in tandem with the flexibility mechanisms of climate agreements through technical assistance and capacity building. The transition from the flexibility mechanisms of the Kyoto Protocol to the Paris Agreement will require a certain level of preparation and commitment. For instance, an improved CDM to measure

sustainable development requires rules, modalities, procedures (Olsen et al., 2019), and the development of transparency, review, and non-compliance elements as well as a strong political will to reduce emissions (Lawrence & Wong, 2017). Setting sufficient emissions targets is also essential for reducing global emissions (Kuriyama & Abe, 2018). A summary of these arguments is presented in Table 8.

Sustainable development goals (SDGs) adopted by the UN member states in 2015 (UN, 2021) aim to achieve prosperity for people and ecology. The SDGs are especially important for developing countries since economic growth and reducing unemployment are the main goals most of the time. However, recent studies indicate that there are certain trade-offs among the SDGs. Especially achieving no poverty goal may harm the environment (Barbier & Burgess, 2019). Matloob et al. (2021) indicate that industrial belts constructed in Southern India are highly correlated with increased carbon concentrations. Ament et al. (2020) found that for 70% of the SDG indicators, SDG status is positively associated with the GDP per capita, and the economic growth is negatively related to health and environmental indicators. Responsible consumption and production goal has a certain level of trade-off with other SDGs implying the significance of energy efficiency in consumption patterns (Fonseca et al., 2020). Therefore, in achieving the SGDs, prioritizing a different set of targets (Ament et al., 2020) and adequate performance measurements (Fonseca et al., 2020) are essential. The interaction among the SDGs is presented in Table 9.

8 Conclusions

This study examined the commitments and flexibility mechanisms introduced in the Kyoto Protocol and attempted to draw implications for developing countries. Although some parties, such as the EU, reduced emissions, global GHG and CO_2 emissions increased dramatically mostly due to increasing emissions in middle-income developing countries. This finding underscores the need for strong and inclusive commitments globally. The ETS serves as one of the main instruments to cap emission levels and contribute to global climate actions such as the Kyoto Protocol and Paris Agreement. EU emission levels, on average, decreased over the implementation period of the Kyoto Protocol. In addition, the EU's FDI outflow in polluting sectors to major emerging markets did not increase overall. Legal, efficiency, and pricing issues should be considered when this mechanism is expanded to cover developing countries. Currently, in some developing countries, such as Turkey, Ukraine, China, Indonesia, Mexico, Colombia, and Chile, the ETS is either scheduled or under consideration (World Bank, 2019c). To construct efficient ETS markets, first, a legal framework must be established, in which the structure of the allowances and financial instruments are clearly defined. Second, efficient markets should be constructed through international and interregional collaboration. Creating national and regional emissions trading schemes in line with the World Trade Organization in future negotiations is also important at this stage.

The CDM experience indicates that low-income developing countries have difficulty accessing and fully benefitting from the mechanism. This issue is quite difficult to tackle, but certain types of policy measures designed specifically for low-income host countries, including technical aid to facilitate access to, and implementation of, related projects can encourage related parties to invest in cleaner technologies in that group. These findings underline capacity development towards more active inclusion of LDCs. The JI project data reveal that most of them are in the area of energy efficiency. This experience can

Table 8 Flexibility mechanisms and policy issues for developing countries

Flexibility mechanism	Issues	Policy action
ET	Legal framework: uncertainty and variation of definitions	Clear definition of allowances to eliminate uncertainties
	Pricing: over-allocation of emissions, price volatility	Alignment of policies and objectives, transparency, cost-effectiveness, environmental integrity
	Sectoral coverage: agriculture, transaction costs	Lower limits, voluntary participation, stakeholder involvement
CDM	Equity: concentration of specific beneficiary host countries. Lower participation of LDCs	Capacity development, governance
	Sustainability: Technology transfer	Policy design towards sustainable technology transfers, inclusion of local industries
	Efficiency: cost structure	Ensuring long-term cost efficiency
JI	Efficiency: unintended emission increases due to high demand for energy	Policy incentives towards energy efficiency in less polluting sectors in the long run

Table 9 Certain SDGs and Interactions. *Source*: Barbier and Burgess (2019); Ament et al. (2020); Fonseca et al. (2020)

SDGs	Synergy	Trade-offs
No poverty	Good health and well-being	Responsible consumption and production Climate action Life on land
Good health and well-being	No poverty Decent work and economic growth Affordable and clean energy	Responsible consumption and production
Affordable and clean energy	No poverty Good health and well-being	Responsible consumption and production
Decent work and economic growth	No poverty Good health and well-being	Responsible consumption and production
Climate action	Responsible consumption and production Life on land Life below water	No poverty

contribute to infrastructure development strategies, determine priority areas for improvement, and technology transfers towards green energy in host countries.

Agriculture plays a major role in the economies of low-income and middle-income developing countries, and the inclusion of that sector in flexibility mechanisms, such as ETS, might be on the agenda. However, high transaction costs and immature financial markets are the main obstacles to be addressed. The issues arising from the structural problems of developing countries should be tackled in tandem with the flexibility mechanisms of climate agreements through technical assistance and capacity building. The SDGs are especially important for developing countries since economic growth and reducing unemployment are the main goals to be achieved. However, recent studies indicate that there are certain trade-offs among the SDGs. Especially achieving no poverty goal may harm the environment. Therefore, in achieving the SGDs, prioritizing a different set of targets and adequate performance measurements are necessary.

The transition from the Kyoto Protocol to the Paris Agreement requires clear definitions of the modalities, procedures, and certain enforcement elements for cases of non-compliance. The definitive solution for climate change should include a set of related policy instruments such as emission mitigation strategies, carbon pricing, investments in cleaner technologies, and global participation in line with sustainable development goals.

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