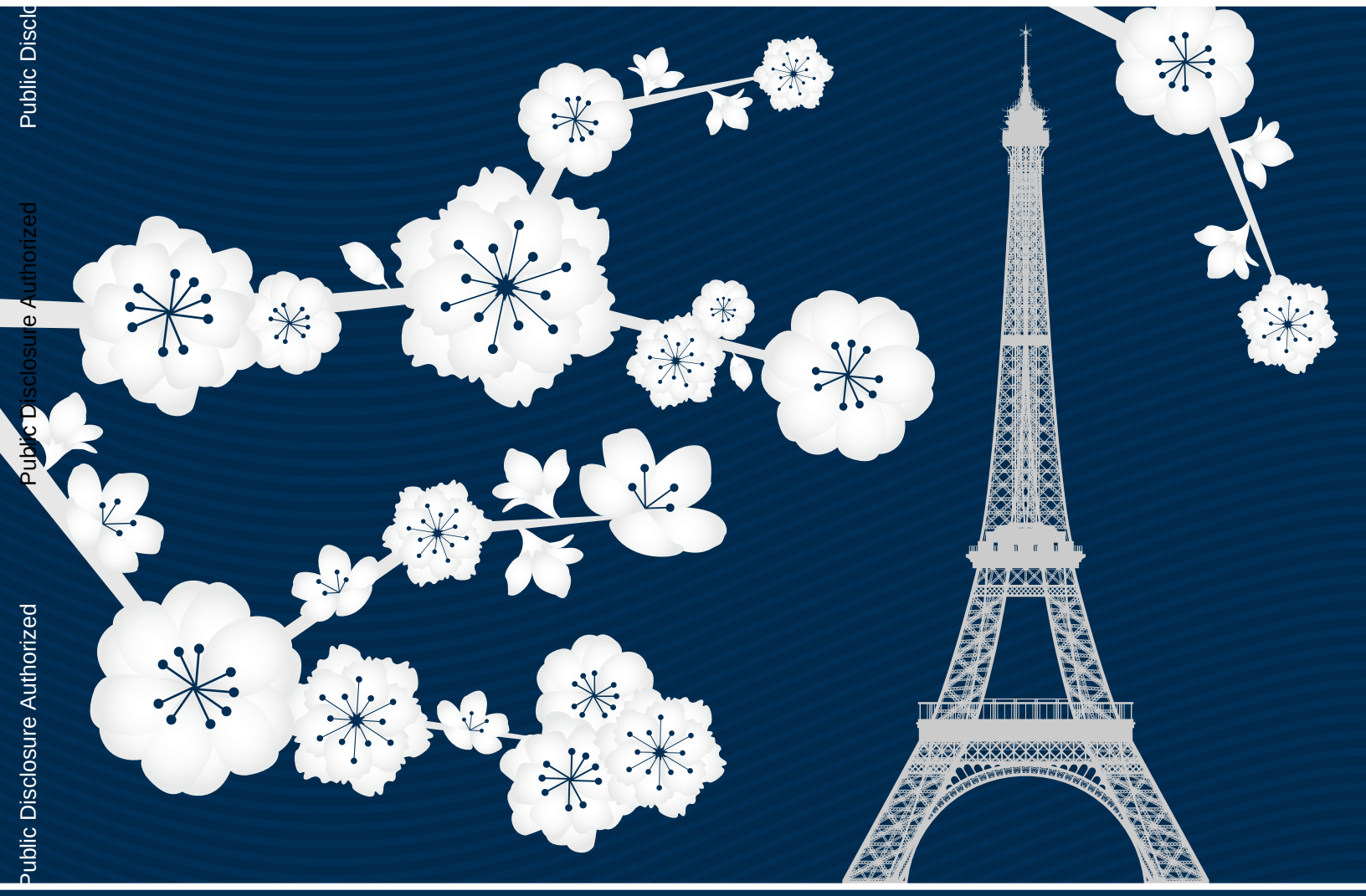
Carbon Markets Under the Kyoto Protocol

Lessons Learned for Building an International Carbon Market Under the Paris Agreement



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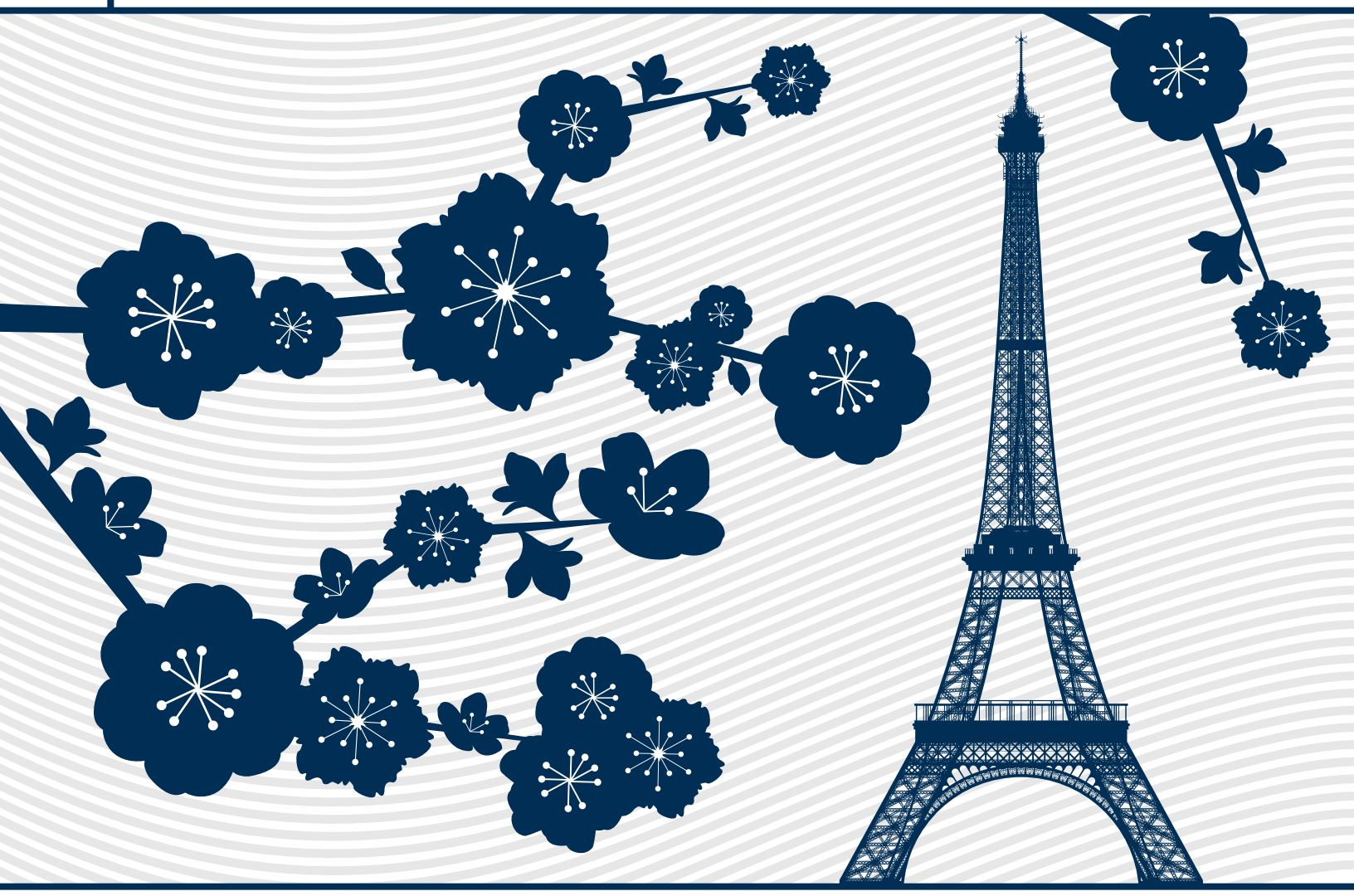

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1818 H Street NW, Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

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Acronyms

A6M	Article 6 Mechanism
AAU	Assigned Amount Units (IET carbon assets)
AIJ	Activities Implemented Jointly
BAC	Baseline-and-Credit
BAU	Business-as-Usual
CA	Cooperative Approaches (PA Article 6.2)
CAT	Cap-and-Trade
CDM	Clean Development Mechanism
CER	Certified Emissions Reductions (CDM carbon assets)
CMA	Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement
CMP	Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol
CP	Commitment Period
CV	Compliance Value
DNA	Designated National Authority
DOE	Designated Operational Entities
EB	CDM Executive Board
EIT	Economies-in-Transition
ERU	Emissions Reduction Unit (JI carbon assets)
ETR	Environmental Tax Reform
ETS	Emission Trading System
EUA	EU ETS Allowance
GHG	Greenhouse Gas
GIS	Green Investment Scheme
ICM	International Carbon Market
IET	International Emissions Trading
ITMO	Internationally Transferred Mitigation Outcome
JI	Joint Implementation
JISC	Joint Implementation Supervisory Committee
KM	Kyoto Mechanism
KP	Kyoto Protocol
MBI	Market-Based Instrument
MV	Mitigation Value
NDCs	Nationally Determined Contributions
NMA	Non-Market Based Approach
PA	Paris Agreement
PDD	Project Design Document
POA	Programme of Activities
PPD	Project Design Documents
SBSTA	Subsidiary Body for Scientific and Technological Advice
SD	Sustainable Development
SDM	Sustainable Development Mechanism (PA Article 6.4)
UNFCCC	United Nations Framework Convention on Climate Change

ES

Executive Summary

Building an international carbon market which reduces mitigation costs while maintaining environmental integrity of the Paris Agreement is a major policy challenge.

Trading carbon assets internationally could reduce the costs of global climate mitigation. By helping facilitate abatement of greenhouse gases at least-cost locations, trading carbon assets across borders could reduce the aggregate costs of combatting climate change. The World Bank's State and Trends of Carbon Pricing report (2016) suggests that comprehensive linking arrangements could reduce global costs of implementing countries' Nationally Determined Contributions (NDCs) by a third in 2030, and by half in 2050. Further, an international carbon market (ICM) may be essential to meeting the global objective of limiting global warming to well below 2°C and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Without an ICM, some countries may be unable to meet their nationally determined contributions under the Paris Agreement, and realizing these costs savings may help countries scale up their climate ambition.

"By helping facilitate abatement of greenhouse gases at least-cost locations, trading carbon assets across borders could reduce the aggregate costs of combatting climate change."

There is currently a rare opportunity to assess the role of carbon markets in the fight against climate change. The de facto end of the Kyoto Protocol and heralding of the Paris Agreement era has created the space for critical evaluation of trading carbon assets. What is needed is a concerted evaluation of the past and an acknowledgement and minimization of the risks of the present, in order to maximize the chances that any ICM can support global climate policy well into the future.

Though carbon markets have detractors, this report argues there is still an economic and political rationale for trading carbon assets across borders. Trade in carbon assets can help reduce the costs of mitigation and facilitate emissions abatement at least-cost locations. When designed well, carbon market mechanisms can also facilitate learning, mobilize the private sector, and encourage transparency of mitigation efforts. Crucially, carbon markets could help support the operating logic of the Paris Agreement by binding signatories together and fostering increases in collective ambition.

A 'good' carbon market could therefore support the global effort to mitigate climate change. Speculatively: success could entail a broad, deep, and liquid carbon market with a variety of fungible instruments traded at prices supported by steady and growing demand. Participating countries would benefit, and Parties would feel empowered to increase their mitigation ambition at the next periodic review of NDCs under the Paris Agreement.

However, an ICM also creates risks. A 'bad' carbon market could undermine trust, environmental integrity, ambition, and the Paris Agreement itself. Failure could entail a mishmash of poorly designed mechanisms and linkages with a patchwork of ill-defined and opaque accounting and MRV processes. In addition, it will take some time for the rules and modalities of the new system to emerge. By contrast, achieving the Paris Agreement's objectives requires substantive abatement efforts now, for which domestic policies such as carbon taxes and emissions trading systems are already available. Anticipating clarity on the Article 6 Mechanisms (A6M), there is a risk that policymakers delay the implementation of domestic mitigation measures, which are needed now.

In addition, decisions taken in the next few years are likely to stick. Though it was not a priority in the Paris Agreement negotiations in 2015, the stakes are now high for an ICM. Given innate path-dependency of institutionalization via the UNFCCC process, the next couple of years will prove crucial in laying a foundation for the A6M.

It is therefore worth reflecting on recent experience. In particular, the partial international carbon market created by the Kyoto Protocol's (KP) 'flexible' mechanisms offer lessons for policymakers. These mechanisms are the Clean Development Mechanism (CDM), Joint Implementation (JI), and International Emissions Trading (IET). The Kyoto Protocol and Paris Agreement diverge markedly in scope, centralization, and logic. As a result, the Article 6 carbon market mechanisms that emerge under Paris are likely to be very different to those that emerged under Kyoto. Nonetheless, experience with carbon markets under the Kyoto Protocol remains informative.

"Anticipating clarity on the Article 6 Mechanisms (A6M), there is a risk that policymakers delay the implementation of domestic mitigation measures, which are needed now."

This working paper critically examines experience with carbon markets under the Kyoto protocol. Drawing on relevant literature and discussion with participants, it seeks to draw out 'lessons learned' from the Kyoto carbon market experience. In doing so, it offers a 'straw man': a perspective on what went well and what didn't. This is intended to inform strategy for creating a new international carbon market under the Paris Agreement's carbon market mechanisms: the 'cooperative approaches' (CAs–Article 6.2) and the 'sustainable development mechanism' (SDM[1]–Article 6.4).

That said, this paper is necessarily limited. The methodology is a broad literature review complemented by discussion with numerous experts. However, operating the Kyoto mechanisms required thousands of people across over a hundred countries around the world, all with their own views and perspectives. Comprehensiveness in this context is not possible, so while the report's mandate is broad, the views contained here are that of the author. The judgments below are therefore a 'straw man' offered to generate discussion.

This study finds:

» **CDM, JI, and IET all had some positives and untapped potential.** However, as 'regulated markets', all were ultimately held back by the political reality of the Kyoto Protocol.

» **The single biggest factor affecting the functioning of the Kyoto market mechanisms was low demand due to low political will.** This emerged in three main ways. Firstly, the country expected to be the largest purchaser of KM carbon assets (the United States) did not ratify the KP. After the US' non-ratification of the Kyoto Protocol, the CDM became wholly dependent on the EU's ETS. Second, the remaining caps were not binding on mitigating countries and remained inflexible. As a result, trading in AAUs and ERUs becoming a major source of controversy, eroding goodwill among countries and in the KP. Third, what little political will remained proved vulnerable. In particular, CDM credit (CER) prices were vulnerable to the collapse in EU ETS credit prices and the unwillingness of its policymakers to shrink the cap following the 2008 financial crisis.

» Numerous attempts were made to tweak and adapt the KM. **However, the mechanisms were not able to overcome this central issue of low demand due to low political will.**

The Clean Development Mechanism (CDM; KP Article 12) is a baseline-and-credit, project-based 'crediting' mechanism operating at the level of firms. It allows projects in non-mitigating countries to generate carbon savings which can be purchased by governments and private sector entities, thereby claimed for compliance purposes by mitigating countries. This study finds:

» **The CDM was a proof of concept at scale. It demonstrated that a project-based international carbon market mechanism could work.** CDM catalyzed private sector participation in mitigation projects at scale. It also helped spread the institutions and knowledge needed for a future international carbon market under Paris. Scale was both broad - with projects in 112 countries, 52 of which had projects amounting to at least 2% of national 2008-12 emissions - and deep in key emerging markets, especially China and India.

» **But, as a result of low demand, prices for CDM credits were unreliable.** CER prices were low and volatile, undermining their credibility as future revenue streams to market participants, impeding participation, scale, and environmental integrity.

» **Combined with high transaction costs and regulatory complexity, supply was also necessarily limited.** Complexity, difficulties in applying consistent standards and unrealistic information requirements were significant issues for project developers and regulators. Along with lengthy procedures and high transactions costs, this blunted participation, especially among less developed countries. Reforms, especially the programmatic CDM ('Programmes of Activities' - PoAs), helped broaden participation. But scale was ultimately limited by the failure to establish a second commitment period and to expand CDM to sectoral- and policy-based crediting.

» **CDM appears to have had some moderate sustainable development co-benefits.** However, these too were limited as development co-benefits went unrewarded, and it remains unclear whether projects helped reduce poverty.

Joint Implementation (JI; KP Article 6) is also a baseline-and-credit, project-based instrument. It allows for carbon assets generated by projects in one mitigating country to be claimed for KP compliance purposes by another. This study finds:

» **JI showed that baseline-and-credit and cap-and-trade approaches could be blended.** However, weakly binding emissions caps under the KP led to deficiencies in demand. The caps under the Kyoto Protocol were not sufficiently stringent to support demand for JI credits (ERUs), invariably leading to concerns about environmental integrity. For instance, some argue that JI may have led to net increases in emissions. If so, this allowed regulated entities in the EU to abate carbon less than they otherwise would have. On the supply side, there was some potential for the proposed Green Investment Schemes (GISs) to address such issues, but ultimately low demand, due to a mix of non-binding caps and concerns environmental integrity, undermined the JI mechanism.

International Emission Trading (IET; KP Article 17) is a bilateral cap-and-trade system. It allows trading among mitigating countries of pre-assigned allowances to allow flexibility in achieving their Kyoto obligations. This study finds:

» **Though Kyoto created the world's first multi-regional cap-and-trade system for emissions allowances, International Emissions Trading (IET) was also ultimately held back by low demand.** Weakly-binding caps under KP, agreed under political premises that could not be sustained after the KP came into force, fed concerns about 'surplus AAUs'. The scale of these surplus allowances meant that trading under IET had the potential to undermine the first commitment period (CP1) and part of the second commitment period (CP2). However, this reflected the central weakness of the KP itself - a lack of political commitment - rather than a problem specific to IET. In addition, despite the lack of stringent caps, IET did provide some flexibility, allowing specific countries to meet their commitments while providing a limited source of funds for others.

"The context and purpose of the mechanisms has changed. All countries now have emissions limitation commitments."

Beyond Kyoto, the context of the Paris Agreement's Article 6 Mechanisms (A6M) is very different:

» **The context and purpose of the mechanisms has changed. All countries now have emissions limitation commitments.** The Paris Agreement will only work if collective ambition is increased over time. Whereas the Kyoto mechanisms were focused on flexibility, the Paris mechanisms need to support ever-increasing ambition. Binding countries together and fostering, rather than hindering, collective goodwill among countries will be crucial. In addition, whereas sustainable development benefits were ancillary for the Kyoto mechanisms, these benefits are more explicitly defined as being part of the A6M.

» **Ensuring that the A6M fosters increases in collective ambition, while supporting sustainable development and the environmental integrity of the Paris Agreement will be a major, ongoing policy challenge.**

» **Whereas the links between national jurisdictions facilitated by the Kyoto's mechanisms were narrowly defined and top-down, A6M implies a world of diverse, bottom-up policy linkages.** Under Kyoto, international 'linkages' of national systems were formally defined. For instance, the EU ETSs' links to project-based credits from developing countries was facilitated under the purview of the CDM. By contrast, under Paris, a much broader variety of international linkages are possible. Linkages, and the units they generate[2], could incorporate numerous different mitigation policies (cap-and-trade, taxes, regulations, and others) while cutting across jurisdictions, NDC types, and other dimensions (refer to Appendix–Varieties of Linkages under the Paris Agreement). Not all of these links will be desirable economically and environmentally or feasible politically and administratively.

Given these differences, not everything that worked under Kyoto will work under Paris. Likewise, not all improvements to the KM would be improvements to the A6M. In addition, SDM and CA are very different to each other. CA allows for decentralized experimentation with policy linkages in the near future. SDM will be overseen internationally, and so it could take many years to agree its modalities and procedures.

Nonetheless, the lessons that policymakers should take forward are:

"A6M implies a world of diverse, bottom-up policy linkages."

» **Embrace the opportunity.** Though it was unexpected, Article 6 could become an important pillar for supporting participating countries to meet their Paris Agreement contributions. Now is a rare opportunity to reflect on how A6M can be designed in an effective, supportive, and legitimate way. Policymakers and academics should reflect and learn the lessons of carbon markets both inside and outside the KP. If the next few years are not handled well, experience with KM suggests that institutional inertia, politicization could lock in a sub-optimal institutional setup.

» **Define success and failure.** Though they were rigidly defined in many ways, ambiguities on purpose and function held back the Kyoto mechanisms. They were variously seen as mechanisms for flexibility in meeting mitigation commitments, cost-reduction, compensation, technology transfer, and sustainable development. Generating a shared understanding of what each of the A6M are for and how they will help support the Paris Agreement will increase the chances of success.

» **Support the Paris Agreement.** Since the signing of the Kyoto Protocol in 1997 the world has changed, and climate policy with it. With its voluntary action, periodic 'pledge-and-review', and weak enforcement mechanisms, the Paris Agreement is a major departure from the KP, and an untested one at that. As a result, the principal purpose of the A6M should be to support the operating logic of the Paris Agreement. At its core, this means supporting countries' desire and ability to increase the ambition of their NDCs. The CAs and SDM should bind countries together, reducing mitigation costs under a transparent framework. In doing so, they should be a conduit through which countries, especially those with high abatement costs, can confidently ratchet up their NDCs. That said, there is an apparent incongruence between the standard economic function of market mechanisms (cost reduction) and this

intended political function (ratcheting up ambition). Squaring this circle, and not losing focus of this foundational purpose, will be a major challenge.

» **Set rules on national baselines and international accounting adjustments carefully.** Accounting for emissions reductions - through the linked concepts of additionality and environmental integrity - were the largest source of controversy for the Kyoto mechanisms. Likewise, accounting and baseline-setting are the biggest sources of risk for the Paris mechanisms. Done improperly, baseline-setting could discourage increases in ambition. Poor accounting at the international level, through inadequate corresponding adjustments and therefore double-counting risks, could undermine environmental integrity. The large body of literature on baseline setting under CDM can inform this, as can learning arising from piloting new approaches, such as policy crediting (generating carbon assets for emissions reductions from domestic policies like carbon taxes - refer to Box 2 below) and sectoral crediting (emissions reductions in a sector, such as power, across multiple jurisdictions).

» **Support meaningful prices with credible and stable commitment.** The low demand environment which blighted the KM underpins the importance of credible commitment to the functioning of carbon markets, including those that cross borders. In addition, government-induced policy uncertainty remains a major impediment investment and innovation globally, including in low-carbon technologies. Supporting prices through credible commitment to stable policies should be a major focus in the design, implementation, and monitoring of the Paris mechanisms. This could include such as price floors and ceilings, with requisite agreement among linked jurisdictions, as well as other 'autocorrection' mechanisms in the case of declining demand.

» **Maintain collective goodwill.** An important lesson from the KM experience is that mechanisms serve as a focal point for Parties. As a result, they can bind countries together, or they can separate them. At times the KM eroded goodwill, appearing to be a zero-sum game, where one parties' gain was another's loss, rather than a positive-sum game, where all participants can win. As a 'softer' agreement, building and maintaining collective goodwill while minimizing suspicions will be even more important under the Paris Agreement. A6M needs to be, in substance and in form, a positive-sum game.

» **Keep what's valuable from Kyoto, but modify.** Much of the structural underpinnings of the Kyoto mechanisms were sound, especially MRV institutions and methodologies. Much of this can be retained for A6M, with modifications including to some of the more onerous methodologies. In addition, CDM and JI inculcated an inclusive culture of governance which did not 'shut countries out of rooms', including those opposed to market mechanisms. This is valuable under Paris. However, at the same time coalitions of the willing ('climate clubs') should be able to operate unimpeded in the 'opt in' spirt of Article 6, rather than 'shut out'.

» **Get governance right.** While international governance institutions under A6M need to be inclusive to ensure the political legitimacy, they should also reflect the reality that such institutions can become inherently political. Politicization of CDM institutions held back the

effective functioning of the carbon market they oversaw. Kyoto's culture of inclusion should be retained under A6M, but international oversight should be limited to where it is essential for political legitimacy and environmental integrity. For CA, this means effective and transparent rules governing international GHG accounting, including corresponding adjustments. For SDM, this means ensuring the new oversight body focuses on implementation rather than policymaking.

» **Manage emerging risks.** A notional world of heterogeneous mitigation policy linkages is unknown. It could offer substantial benefits, but also will carry risks, including the risk of a wholehearted collapse in carbon prices. Unlike under Kyoto, these risks should be monitored and understood at the international level, using recent advances in network science, complexity theory and macroprudential policy.

» **Reward sustainable development (SD) while managing distributional effects.** SD was a key stated objective of the CDM, but evidence on scale is mixed. SD benefits were ambiguously defined and went unrewarded in carbon finance revenues. This shifted the CDM pipeline away from more expensive projects with high non-mitigation social returns. A future SDM should reward projects and policies with high SD benefits. How to bring about such an 'SD premium' remains a key unresolved issue given the lack of a reward mechanism, alongside apparent tradeoffs (whether substantive or perceived) between SD and mitigation that arose during the operation of the KM. In addition, future linkage of emissions systems under the Paris Agreement will have distributional effects within participating countries. These need to be managed to ensure that poverty and distributional objectives are not adversely affected.

» **Support capacity-building efforts and knowledge sharing.** With Paris, a majority of countries have entered unknown territory: implementing domestic mitigation policies to meet international commitments. The bottom-up logic of A6M makes knowledge sharing even more important for its effective use. A big push is needed on capacity-building, cooperation and knowledge sharing of mitigation policies generally, including market mechanisms. This is relevant for all, but especially low-income countries.

» **Encourage symbiosis between carbon finance and climate finance.** There are indications that private finance from carbon markets was crowded out by the public finance of overseas development assistance. This is backwards both politically and economically. A concerted effort is required on behalf of international institutions and national donors to ensure that public climate finance is supplemental and complements private finance mobilized by carbon markets.

» **Generate knowledge of long-standing proposals, especially policy and sectoral crediting.** Numerous ideas for scaling the Kyoto mechanisms better were held back due to the path-dependency of UNFCCC institutions. As a result, collective policy experience is lacking. Now there is an opportunity to build and share this experience. Policy and sectoral crediting are particularly attractive, especially for carbon pricing policies, although there is a strong need for further analytical work. Enlisting volunteers to pilot these approaches and disseminate learning should be a priority.

» **Pilot new approaches.** A big push is needed to experiment and demonstrate the feasibility of new concepts and approaches under the A6M. This entails experimentation and an embrace of innovative new ideas, especially given the gulf in mitigation experience in most countries. Untested initiatives include those set out under networked carbon markets, e.g. 'carbon buyers clubs' and differentiated mitigation values of assets. These ideas are worth exploring further, while being cognizant of their numerous technical, administrative and political obstacles. Emerging technologies could also support the development of the Paris mechanisms, notably blockchain. Clarifying, testing and piloting ideas and technologies such as these could help in the development of an effective international carbon market which supports the Paris Agreement.

» **But do not wait to abate.** Though trading of ITMOs may provide numerous benefits in the future, governments should not wait to ambitious implement domestic mitigation policies now. There remains a substantial mismatch between ambition reflected in the NDCs and existing national policies. Policymakers should seek to implement domestic mitigation policies, notably carbon taxes or other market-based instruments such as emissions trading systems, in line with their NDCs now. These policies can have numerous development co-benefits, such as direct improvements in human health and welfare, even before climate benefits are considered. **Policymakers should therefore seek to implement domestic mitigation policies, especially carbon pricing, as soon as possible.**

01

Introduction

"You don't know where you're going until you know where you've been."
–English proverb

International trading of carbon assets has the potential to drastically lower the costs of mitigating climate change. By linking emissions systems abatement of greenhouse gases can take place where it is cheapest. As a result, creating an international carbon market (ICM) could lower the costs of the Paris Agreement's 'nationally-determined contributions' (NDCs) by a third by 2030 and a half by 2050 (World Bank 2016, 80). Crucially, without the flexibility offered by a scaled-up ICM, it is questionable whether some countries can ever meet their targets, jeopardizing the goal of limiting global warming to below 2 degrees.

As a result, the creation of an effective ICM has been an underlying objective for many countries and stakeholders in the UNFCCC process.[3] The Kyoto Protocol (KP)—signed in 1997, in force from 2005, and with first commitment period (CP1) of 2008-12—was not ratified by all countries. However, experience under the three 'flexible' Kyoto mechanisms (KM) provides some grounds for experience. With the failure to establish a second commitment period (CP2), and with the signing of the landmark Paris Agreement in 2015, KP has been all but been abandoned, with its 'flexible' mechanisms left in limbo. Meanwhile, the Paris Agreement 'Article 6' mechanisms (A6M) have yet to be clarified. A number of important questions remain for negotiators and other stakeholders in the UNFCCC process to address in the coming months. The long experience of agreeing, designing, implementing, and managing the Kyoto mechanisms is instructive for this process.

"This report seeks to elucidate some of the key 'lessons learned' from the Kyoto mechanisms to help inform those seeking to create an ICM under the Paris Agreement."

This report seeks to elucidate some of the key 'lessons learned' from the Kyoto mechanisms to help inform those seeking to create an ICM under the Paris Agreement. It does so through analysis of primary data and legal texts, review of a large body of literature, and discussions with academics, policymakers, and practitioners. This is intended to inform policymakers, academics, practitioners, and negotiators seeking to implement Article 6.

The study is organized as follows. The second section presents a typology of carbon market mechanisms, comparing the three Kyoto mechanisms with the incipient Paris mechanisms. The third, fourth, and fifth sections analyze the Kyoto Mechanisms (KM) retrospectively, examining what went well, what did not go well, and what the key controversies were. The sixth and final section presents some key lessons learned that have emerged. **This is not a comprehensive review of the Kyoto mechanisms, but a 'straw man' which offers lessons learned to help inform the creation of the Paris Agreement's A6M.**

02

Background

This section introduces carbon market systems in general, and compares the Kyoto and Paris Agreement mechanisms in particular.

2.1 Carbon market systems typology

There are two main types of carbon markets: cap-and-trade (CAT), also known as 'emissions trading systems' (ETSs) or simply 'trading systems'; and baseline-and-credit (BAC), or simply 'crediting systems'. Trading systems are defined by their coverage, including locations, sectors, entities and gases. Crediting systems are defined by the different types of activities that are eligible to be credited, such as projects, programmes, sectors, policies or actions.

CAT systems facilitate the exchange of carbon assets (permits) within a fixed level of total emissions. Under a CAT, a fixed emissions level is established and tradeable 'allowances' or 'permits' are assigned to regulated entities[4] through auction or free allocation. These allowances have a price set by the market or regulator. Entities that are able to reduce their own emissions internally at a cost below the value of allowances can choose to do so, selling excess allowances to entities for whom emissions abatement costs are above the allowance price. These allowances have become 'offsets' because their use by one entity, was offset by reductions from another. As a result, trade in carbon assets allows abatement to take place where it is cheapest (cost-effectiveness), but does not reduce total emissions (overall abatement). Only by shrinking the total number of allowances in the system can total emissions be reduced.

By contrast, BAC systems reward generation of 'additional' emissions reductions below a certain level of total emissions with carbon assets (credits). Under BAC, a baseline level of emissions is established, based on historical or projected emissions. Projects or policies which shift emissions below this baseline generate tradeable 'credits'. These credits are, in theory, 'additional' if the original baseline was correct and (in a stricter interpretation of additionality) the emissions reductions would not have happened without the project or policy. If the credits are purchased by another entity to demonstrate compliance, e.g. within the jurisdiction of the BAC or a separate CAT system, the credit has also become an 'offset'[5]. **In this way, a jurisdiction's emissions can be covered by a CAT system, a BAC system, or a mixture of both.**

CAT and BAC systems can help reduce the costs of emissions abatement. Both are 'market-based instruments' (MBIs) in that they are regulations which adopt market principles to achieve environmental objectives (e.g. overall emissions reductions) in a decentralized manner. By providing incentives towards market participants in the form of carbon assets prices, both systems can help

ensure that emissions abatement to take place at least-cost locations (e.g. power plants or firms).[6] By contrast, for direct regulatory measures to achieve least-cost emissions abatement, regulators would need to know plant- or firm-level emissions costs. It is unlikely that regulators will have such 'perfect information', however. MBIs, which do not require such knowledge, may be more likely to achieve least-cost emissions abatement.

However, both systems also have intrinsic weaknesses. For instance, they do not fully overcome informational issues. From an economic perspective, both systems create 'regulated' markets, rather than 'natural' markets.[7] As a result, they must be designed and implemented by policymakers who necessarily lack information about the present and the future. Imperfect information can therefore still impede the operation of both systems. Poorly-designed CAT systems can suffer if forecasts underpinning allowance allocations deviate. BAC systems suffer from inherent uncertainty as to whether the baseline is 'correct', making 'additionality' and thus acceptability of any carbon credit unclear.

Crucially, both CAT and BAC systems entail an element of uncertainty over prices. Both are 'quantity instruments', in that they give firms, households, and policymakers some certainty over future emissions levels (the cap or baseline), while allowing prices to fluctuate. By contrast, 'price instruments' like carbon taxes give more certainty over price levels (the tax), while allowing emissions to fluctuate. For quantity instruments, if market forces fluctuate and regulatory policies change then prices can shift, making future incentives faced by entities uncertain.[8] **This inherent issue of price uncertainty under carbon market systems became a major issue for the Kyoto mechanisms.**

"CAT and BAC systems are 'quantity instruments', in that they give firms, households, and policymakers some certainty over future emissions levels, while allowing prices to fluctuate."

2.2 The Kyoto Mechanisms (KM)—CDM, JI and IET

Signatories to the KP are divided into two camps on developed-developing country lines. The first, so-called 'Annex I' Parties[9], are required to reduce or limit their emissions against a pre-defined historical baseline. The second, 'non-Annex I' countries do not have quantified emissions mitigation requirements. Countries can trade with each other through three 'flexible' mechanisms: IET, CDM and JI.

International Emission Trading (IET; KP Article 17) is a bilateral cap-and-trade system. It allows trading among mitigating states (Annex I Parties) of pre-assigned allowances, known as 'assigned amount units' (AAUs). This was to allow flexibility to help mitigating countries achieve their Kyoto obligations. Kyoto also allowed the issuance and trade under IET of 'removal units' (RMUs). These units represent a tonne of GHG absorbed due to land use, land-use change and forestry (LULUCF), for instance as a result of reforestation. There is no evidence of RMUs being traded under IET, though there were some limited trading of AAUs.

The Clean Development Mechanism (CDM; KP Article 12) is a baseline-and-credit, project-based system operating at the level of firms. It allows projects in non-mitigating countries to generate carbon savings ('certified emissions reductions'—CERs) which can be purchased by governments

and private sector entities, thereby claimed for compliance purposes by mitigating countries. The CDM is supervised by the CDM Executive Board (CDM EB), which consist of an equal number of individuals from Annex I and non-Annex I Parties and which is accountable to the KP's governing body within the UNFCCC, the CMP[10]. China, India, South Korea and Brazil account for 85% of all issued CERs (Shishlov, Morel, and Bellassen 2016).

Joint Implementation (JI; KP Article 6) is also a baseline-and-credit, project-based instrument. It allows for projects between mitigating countries to generate carbon assets known as 'emissions reduction units' (ERUs). ERUs generated in one country can be claimed for KP compliance purposes by another. Further, a country can convert its AAUs or RMUs to ERUs and then trade them. JI has two tracks: track 1 which allows countries to generate ERUs without international oversight; and track 2, where projects and the generated ERUs are overseen by the Joint Implementation Supervisory Committee (JISC). JI emerged out of a pilot program which began in 1995,[11] coming into force with the KP in 2005, but the first project was not registered until 2007. Ukraine and Russia account for 90% of issued ERUs and 97% were issued under track 1.

These three mechanisms enabled the trading of carbon allowances (AAUs under IET) or credits (ERUs under JI) between mitigating countries, and credits between mitigating and non-mitigating countries (CERs under CDM). **By combining cap-and-trade with baseline-and-credit systems, KP was itself effectively a hybrid international carbon market.**

2.3 The Paris Agreement Article 6 Mechanisms (A6M)—CA and SDM

The explicit inclusion of market mechanisms in the Paris Agreement was not preordained (Widge 2015; Stavins 2016b). Although markets had been discussed within the UNFCCC in the run-up to Paris, 'how' to mitigate tended to be peripheral to the question of 'which' countries should limit or reduce emissions in the first place. While much is yet to be agreed, Articles 6.2-3 and 6.4-7 lay the framework for an international carbon market to emerge, with their usage formally recognized under the Paris Agreement.

Article 6.2 defines 'cooperative approaches' (CA) that countries can take for the purposes of reaching their NDCs (UNFCCC 2016, Art. 6.2). Parties can exchange 'internationally transferred mitigation outcomes' (ITMOs) on a voluntary basis to meet participating countries' NDCs. Countries are required to ensure that trading promotes sustainable development, ensures environmental integrity and transparency including in governance, and avoids 'double counting'.[12]

CA is not itself a specific mechanism; it is formal recognition that a variety of linkages between climate actions will be valid under the Paris Agreement. This could include, *inter alia*, transfers of carbon assets generated from international crediting mechanisms (similar to the CDM, for instance), domestic market-based instruments (from domestic cap-and-trade systems, crediting mechanisms, renewable energy or energy efficiency certificates, and carbon taxes, for example), as well as direct bilateral transfers of MOs. This open-endedness creates the space for a plethora of new linkages between national mitigation policies to emerge that would not have

been recognized under the Kyoto Protocol. For instance, under KP there was no formal way for an ETS in an Annex I country to be linked to a carbon tax in a non-Annex I country.[13]

Article 6.4 calls for what is being dubbed a 'sustainable development mechanism' (SDM). The SDM is likely to be a project-based crediting mechanism similar to CDM, except that both host and purchasing countries will have emissions reduction or limitation commitments.[14] The stated purpose of the mechanism is to increase ambition, incentivize private and public participation in mitigation, contribute to meeting NDCs, foster sustainable development and deliver "overall mitigation in global emissions" (UNFCCC 2016, Art. 6.4). The SDM will be under the formal authority of Parties to the Paris Agreement (CMA) and overseen by a UNFCCC body. The CMA has tasked one of the UNFCCC subsidiary bodies (SBSTA) to develop rules, modalities and procedures for SDM (UNFCCC 2016, para. 38). These should be drawn up on the basis of voluntary participation, 'real, measurable and long-term benefits' to mitigation, verification of designated entities involved in projects, and informed by "lessons learned from existing mechanisms" (UNFCCC 2016, para. 37; refer to Box 1 for current status).

Box 1 Paris Rulebook update

As of July 2018, the rules, modalities, and procedures for CAs (Article 6.2) and the SDM (Article 6.4) of the Paris Agreement had yet to be agreed by Parties to the Paris Agreement. These form part of discussions of the 'Paris Rulebook', which comprises implementation details for the Paris Agreement as a whole, with a deadline for agreement and adoption by COP24 (December 2018). At the time of writing, this was continuing to be discussed in the subsidiary body within the UNFCCC (SBSTA). In March 2018, SBSTA published 'informal notes' facilitate these negotiations, clarify options, and develop implementation language:

- For CAs (Article 6.2), the informal note contains draft elements of guidance on voluntary cooperative approaches which involve the transfer of mitigation outcomes (ITMOs) towards NDCs, formalized through bilateral or multilateral agreements. This elaborates on the characteristics of an ITMO, including whether units under the Article 6.4 mechanism, certified emission reductions (CERs) from CDM, as well as mitigation outcomes beyond emission reductions (such as co-benefits of adaptation actions and economic diversification) can qualify as ITMOs. It also discusses the type of NDC parties need to make use of CAs, how and when Parties can make corresponding adjustments to NDCs, and the modalities for the share of proceeds for adaptation (UNFCCC 2018c).

- For the SDM (Article 6.4), the informal note contains draft elements of the rules, modalities and procedures for the mechanism under Article 6.4 covers a wide range of design options, ranging from a new design to one drawing heavily on the CDM. It also discusses potential references to compliance with Article 6.2 requirements as a pre-requisite, and the start date of issuances under the new mechanism (UNFCCC 2018d).

These proposals, and other elements of the Paris Rulebook, are due to be discussed in Bangkok in September 2018.

However, it is still far from clear what the CAs and SDM will look like in practice. Numerous questions remain. For example, this includes: how will the CAs promote sustainable development while preventing double-counting?; how will ITMOs be defined and generated and by which body?; how will credits generated by SDM be claimed by host and purchasing country for meeting their NDCs?; and, how will SDM achieve 'overall mitigation' in global emissions? Whatever the rules, modalities, and procedures turn out to be, **the stated intention of A6M is "to allow for**

higher ambition in [Parties'] mitigation and adaptation actions and to promote sustainable development and environmental integrity" (UNFCCC 2016, Art. 6.1, emphasis added).

2.4 Comparison between KM and A6M

The KM and A6M share a number of similarities and differences.[15] From a 'lessons learned perspective', key similarities include their genesis and purpose. **Key differences include their function and the operating logic of the agreement they support.**

2.5 Similarities

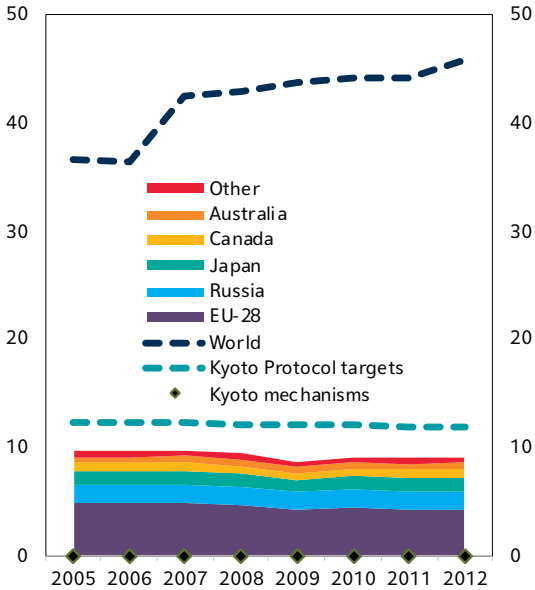
The Kyoto and Paris Agreement, and their respective market mechanisms, emerged out of the UNFCCC. As such, they are products of complex process. In the UNFCCC process, detail and interpretation are frequently delegated to discussion among the numerous working groups at future meetings, where substantive differences in interpretation and intent can emerge. Such differences can frustrate progress. **As a result, while their modalities are yet to be agreed, the A6M under Paris may well face the same delays that KM suffered under Kyoto.**

The KM and A6M both are intended to support their respective agreement's objectives. As such they are both overseen by the designated body of the signatory Parties to each: CMP for Kyoto and CMA for Paris, respectively. Both are also explicitly voluntary, making their usage contingent upon the willingness of countries to engage in the administratively costly process of creating and implementing them. **Both A6M and KM share the same broad purpose: to lower the overall costs of abatement to flexibly facilitate the reaching of mitigation targets while supporting sustainable development.**

2.6 Differences

However, A6M and KM differ in a number of important ways. Firstly, the scope of the agreements they support diverge. The KP binds certain signatory countries (Annex I) into explicit, quantitative and negotiated emissions limits while exempting others (non-Annex I). The effective number of mitigating countries was 36, which accounted for just 21% of global emissions during the first commitment period (2008-12; refer to Figure 1).[16] By contrast, as the first comprehensive agreement signed under the UNFCCC, the 194 signatories of the Paris Agreement covers approximately 98% of global emissions.[17]

Figure 1 Kyoto Protocol targets and global emissions



Source: data from Shishlov, Morel, and Bellassen (2016). Shows Kyoto Protocol targets (dashed red line, GtCO2e) compared with actual emissions of Annex I countries (area, split by country), overall global emissions (dotted blue line), and annual issues of all KM carbon assets (black diamonds) during commitment period 1 (CP1), 2005-12. Kyoto targets covered a just 21% of global emissions, and remained above the actual emissions of Annex I countries throughout CP1. Annual issues and trades of all KM carbon assets (black diamonds) remained a small fraction of global emissions throughout the first commitment period.

Secondly, the operating logic of the agreements A6M and KM support diverge. The Kyoto Protocol is a fixed, legally-binding agreement with overt penalties for non-compliance. If Annex I countries failed to reduce or limit their emissions to their assigned amounts (AAUs) they could theoretically be punished, including by limiting their access to international carbon assets. By contrast, the Paris Agreement adopts a 'pledge and review' system. Countries make voluntary contributions which are collectively reviewed periodically (every five years) with the intention of increasing collective ambition over time. There is no way to force a country to meet its NDC, beyond 'naming and shaming' in the UNFCCC and by civil society. It is therefore weaker in terms of enforcement than KP.

Thirdly, national emissions caps and possible linkages under Paris are more ambiguously defined than under Kyoto. Under Kyoto countries had clearly defined historical (1990) baselines and targets. Under Paris, NDCs are subject to change through the five-year review process. Future baselines are therefore dynamic and ambiguous. This uncertainty is compounded by the large variety of NDC types. This includes targets against historical or future 'business as usual' baselines, emissions intensity targets, and renewable energy targets. Although a large variety of linkages are possible between policies of jurisdictions with different NDC types, not all are possible or desirable (refer to Appendix - Varieties of Linkages under the Paris Agreement). The ambiguity over national baselines, modalities and procedures and the set of possible and preferable linkages means A6M, and the institutions which govern them, are likely to continue to face a high level of uncertainty.

"The ambiguity over national baselines, modalities and procedures and the set of possible and preferable linkages means A6M, and the institutions which govern them, are likely to continue to face a high level of uncertainty."

03

What worked well?

Key positives from the Kyoto mechanisms from a 'lessons learned' perspective include: providing a 'proof of concept' at scale, helping spread familiarity with climate policies, fostering national MRV and GHG accounting systems, and mobilizing private sector participation in climate mitigation.

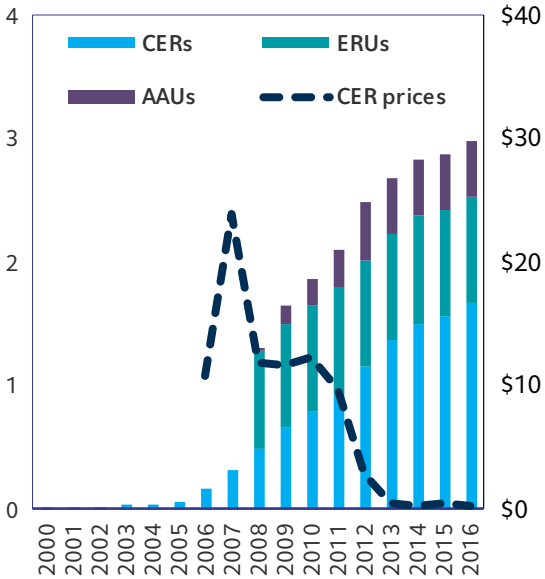
3.1 Proof of concept

"CDM was the largest of the Kyoto mechanisms in volume and successfully institutionalized a complex, first-of-its-kind global carbon crediting system."

While they had numerous flaws and controversies, the Kyoto mechanisms proved that international carbon markets were possible at scale: an 'ICM 1.0'. Creating an international carbon market is not simple politically or administratively. Doing so entails generating international and national standards for MRV and GHG accounting, governance and oversight procedures, and mutual recognition of units. Kyoto made progress on all these fronts, both in the core trading system of AAUs allowed for by IET and in the crediting mechanisms of JI and CDM.

CDM was the largest of the Kyoto mechanisms in volume and successfully institutionalized a complex, first-of-its-kind global carbon crediting system. This included: modalities and procedures, interpreted by the CDM Executive Board and overseen by the CMP; defined methodologies for baselines, additionality, and emission reduction calculations; eligibility criteria for small-scale projects and broader 'programmes of activities' (PoAs); standardized project design documents (PPDs); approval by a host country's 'designated national authority' (DNA); validation by independent 'designated operational entities' (DOE); project registration by an international governance body (CDM Executive Board); and finally generation of emissions reductions, their verification by DOEs, certification, issuance and accounting by the CDM EB. There was no guarantee that this process would work, and numerous critiques can be levelled at each step. **However, these processes were successfully formulated, reviewed, and improved over time.**

Figure 2 Kyoto mechanisms volumes and prices

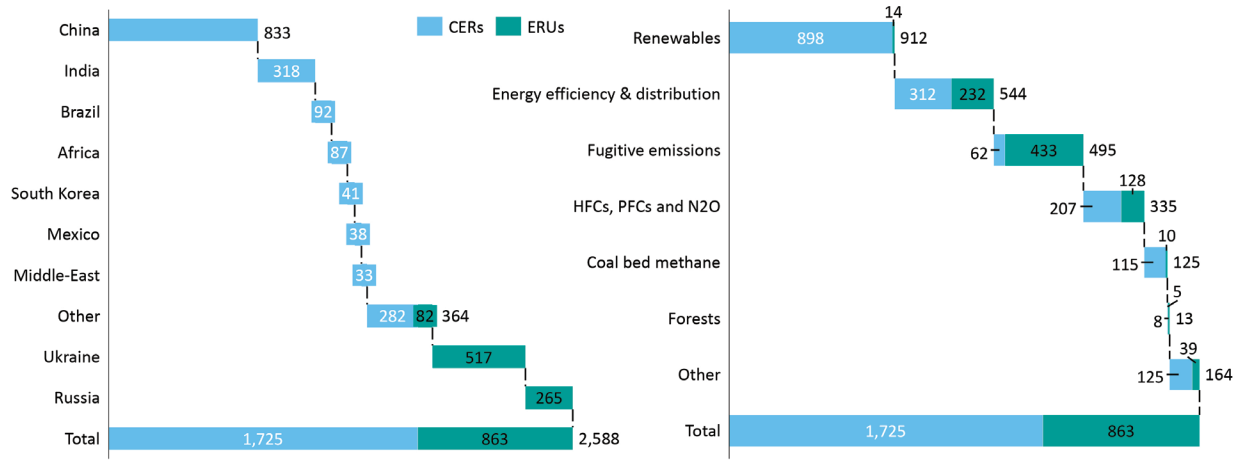


Source: data from UNEP (2018). Shows cumulative issues of CERs or ERUs and AAU trades (left-hand axis, millions of carbon assets), as well as prices of CERs (right-hand axis, US$) between 2000-2016. JI projects include both Track 1 and Track 2 available for public comment. AAU trades include all AAUs exchanged and listed on the JI Pipeline.

In terms of scale, CDM scaled slowly between 2000-13, compared to JI which spiked in 2008 (Figure 2). By 2016, a total of 1,725m of CERs and 863m ERUs had been issued.

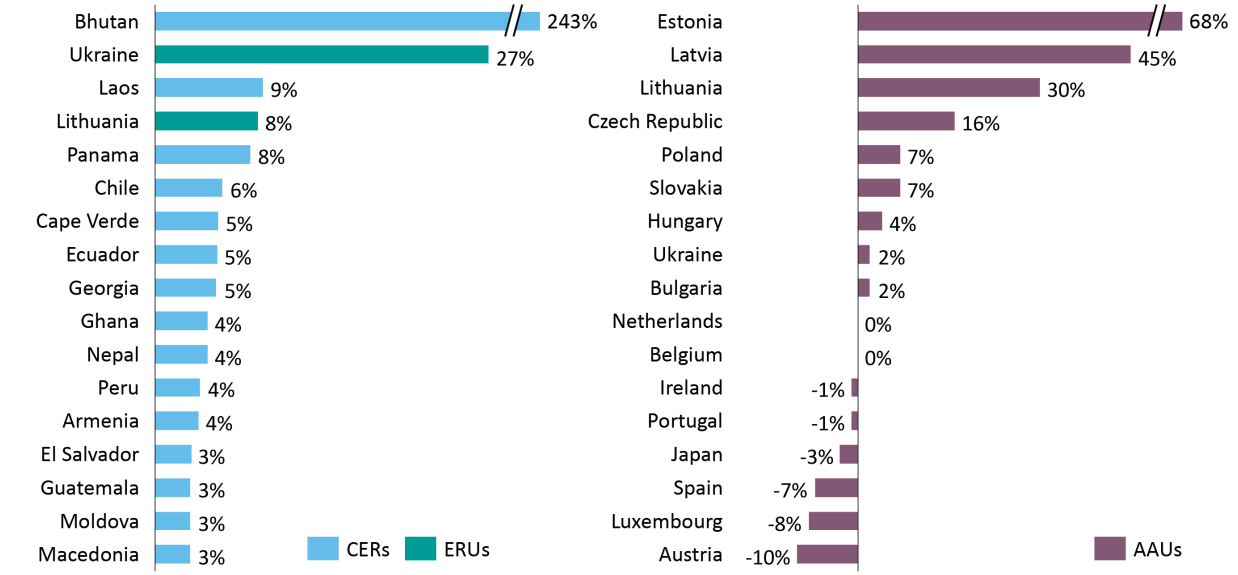
A majority of CERs and ERUs were generated by a small

Figure 3 CER and ERU issuances - millions registered 2000-17



Source: data from UNEP (2018). Shows total CERs (blue) and ERUs (green) issued by country or region (left-hand panel) and type (right-hand panel) between 2000-17. CERs were mostly issued by China and India, while ERUs were predominately issued by Ukraine and Russia. CERs were mostly from emissions reductions from renewables and energy efficiency & distribution projects, while ERUs were mostly from fugitive emissions and energy efficiency & distribution projects.

Figure 4 Kyoto mechanism usage intensity by country



Sources: data from UNEP (2018) and WRI (2018). Shows CER and ERU issuances (left-hand panel), and net AAU trades (right-hand panel, equals sales minus purchases) as % of 2008-12 emissions by country. Bhutan's emissions between 2008-12 were approximately 5.2 mtCO2e, while it generated 13.9m CERs. This is due to large dam projects, which exported energy to India and therefore reduced emissions outside of Bhutan greater than its total emissions.

number of countries (Figure 3). CERs issuances mostly related to projects in China (48% with 834m) and India (19% with 320m). Issues were equivalent to 1.7% 2008-12 emissions for China, and 2.5% for India. ERUs were mostly issued by Ukraine (60% with 517m) and Russia (31% with 265m). This covered 28% of 2008-12 emissions for Ukraine and 2.5% for Russia.

However, CDM and JI had a nonnegligible impact on emissions beyond these countries (Figure 4). By March 2017, there were 12,400 projects from 112 host countries in the pipeline. CERs accounted for at least 2% of the 2008-12 emissions of 28 countries and at least 1%

emissions for 52 countries. CDM and JI covered 0.8% and 0.4% of global 2008-12 emissions, respectively (UNEP 2018; WRI 2018).

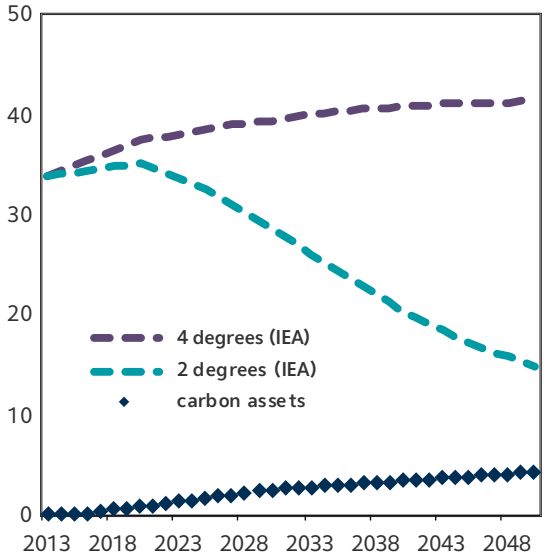
CDM also helped support a large amount of domestic and international investment. Though estimates vary, the UNFCCC stated that by 2014 CDM had supported 8,000 emissions-reduction projects in developing countries worth at least $138bn (UNFCCC 2014a).[18] For scale comparison, this is equivalent to about 13% of total renewable energy investments in developing countries over the period 2006–14 (World Bank 2015, 35).[19]

CER issuances could have kept growing had the second commitment period (CP2) come into force. With the end of the first commitment period, and with it the end of CERs being accepted in the EU ETS and other trading systems and by governments for compliance, there is a glut of surplus CERs. The existing CDM pipeline alone could potentially support 3.5bn CER issuances between 2016 and 2020, roughly double the total of all CERs registered. However, a figure of 300-600m is more realistic given market conditions and a questionable future for CDM (World Bank 2016, 37).[20]

In their peak year of 2008, CDM and JI volumes were large. Although they were helped by a long lead time to the first year of CP1, in 2008 the CDM and JI generated 966m CERs and ERUs. Arguably, this volume was equivalent to between one fifth and one half of carbon asset issuances required to support the Paris Agreement's objectives. One study (World Bank 2016) suggests that 2,495m and 4,310m of carbon assets would need to be traded each year by 2030 and 2050, respectively (refer to Figure 5).

That said, because CDM and JI were 'project-based' mechanisms they necessarily missed a large opportunity for scale: policy crediting. Policy crediting is the generation of carbon assets for emissions reductions resulting from changes in policy. This includes policies such as fossil fuel subsidy reform or energy efficiency standards (Wooders et al. 2016). While the emergence of 'programmes of activities' (PoAs), whereby small-scale projects could be grouped and approved together, helped accelerate scaling of CERs by the end of the first crediting period, the explicit exclusion of policy crediting was an oversight from the perspective of scale (refer to Box 2).

Figure 5 Paris Agreement emissions & carbon assets



Source: data from UNFCCC (2017), World Bank (2016), and IEA (IEA 2016). Shows emissions trajectories consistent with achieving 4 degrees (black dotted line, GtCO2) and 2 degrees (red dashed line) of average warming, along with projected annual volume of carbon asset trades consistent with a 2-degree pathway (black diamonds; pathway extrapolated from 2030 and 2050 estimates), 2012-50. Trajectories are consistent with a 50% chance of limiting the average global temperature to 2 and 4 degrees increase.

For IET, because Kyoto created clear and mutually-agreed emissions targets between mitigating countries it allowed for the trading of AAUs and ERUs. Trading volumes turned out to be lower than expected in aggregate, with a total of 0.9bn AAUs traded between mitigation countries. This was primarily due to the relative ease of meeting the Kyoto commitments: mitigating countries simply did not need to make use of the mechanism. In addition, making use of IET became

Box 2 Policy crediting for carbon pricing

Policy crediting is the crediting of emissions reductions due to the implementation of a policy action or components of it. For example, a jurisdiction could implement an energy-efficiency policy and generate credits ('mitigation outcomes'' in Paris Agreement nomenclature) for the emissions abatement that the policy resulted in, versus a baseline of no (or less stringent) policy.

Policy crediting is attractive because the scale of mitigation could theoretically dwarf that of project-based mechanisms such as the JI and CDM. By their nature, projects are limited in size, and scale linearly with their administration costs (the number of DOEs, for instance).[21] By contrast, policies tend to have fixed or negligible administration costs, and can scale across an entire economy. As a result, more credits can be generated, contributing to increased scale in international trading of mitigation outcomes. In discussions about A6M, crediting approaches using sectors or other aggregates such as cities have been discussed. But while policy crediting has been discussed since before the operation of the KM, it remains a new and untested approach, and the literature is limited (Wooders et al. 2016).

A potential set of policies for crediting, which has attracted attention recently, are carbon pricing policies. Carbon pricing, including carbon taxes and emissions trading systems, are generally more cost-effective instruments for achieving broad environmental objectives than alternative policies such as direct regulation. As a result, they have increasingly become a focal point in discussions of climate mitigation. However, coverage and scale of carbon pricing remains low. In 2018, there were 47 carbon tax and ETS schemes (including national and sub-national schemes) covering just 15% of global emissions. Prices also remain low, mostly below in the US$2-$10/tCO_2 (per tonne of CO_2) range. This is well below those required to cost-effectively achieve the Paris Agreement, estimated by the 'High-Level Commission on Carbon Prices' at between US$40 to 80/tCO2 by 2020 and US$50 to 100/tCO2 by 2030 (Stiglitz et al. 2017). In addition, few developing countries have carbon pricing policies.

In order to facilitate an increase in carbon price coverage and level, some have advocated international policy crediting for carbon pricing (Steckel et al. 2016). For instance, a government could raise energy prices by implementing a carbon tax while using revenues raised to fund increases in infrastructure investment or social spending. Such reforms—those which combine environmental taxes (like carbon taxes) with expenditure and other policies—are known as 'environmental tax reforms' (ETRs). These have a number of desirable properties in their own right, including co-benefits like improvements in human welfare. However, they could become even more attractive if they were able to generate ITMOs. Revenues raised could then be used to further increase social spending, to compensate any lower-income groups affected by increased energy prices, or on supplementary policies like investments in clean energy.

However, there a number of challenges to policy crediting. Baseline-setting is major problem, as the experiences with 'additionality' under CDM and JI demonstrated, though recent guidance has been published on this.[22] For carbon pricing policy crediting in particular, the incentive may not be significant. One analysis of four case studies of national policies (in Morocco, Indonesia, Mexico, and China) found that external crediting was unlikely to contribute significantly to revenues raised or to compensation for lower-income groups (Wooders et al. 2016). In addition, the political risks of policy crediting being perceived as domestically 'foreign interference' may outweigh gains. Lastly, it is not clear how 'flexible' such policy crediting would be. As a result, more research, analysis, and crucially piloting is needed in this area.[23]

politicized due to concerns about the environmental integrity of surplus AAUs. That said, for some countries AAU trades represented a large portion of emissions (Figure 4). Large sellers relative to their emissions include Estonia (68% of 2008-12 emissions), Latvia (45%), and Lithuania (30%). Large purchasers relative to emissions include Austria (10% of 2008-12 emissions), Luxembourg (8%), and Spain (7%). The biggest sellers in aggregate were Poland (138m) and Czech Republic (103m), and the largest purchasers were Japan (206m) and Spain (115m).

In all, 17 of the 37 mitigating countries made use of IET to meet their emissions commitments or gain revenues from selling. Caps under the Kyoto Protocol were easy to meet, limiting the demand for AAUs between countries. Indeed, trade volumes through IET were dwarfed by the number surplus AAUs (see section 5.1 on Environmental integrity below). However, IET did provide a framework for the first global cap-and-trade scheme for emissions allowances which could have scaled further if it was needed, and hence may have added 'flexibility' to the Kyoto Protocol.

3.2 Learning

Another positive of the KM experience was the diffusion of knowledge about climate change and mitigation policies in developing countries. Before the CDM there was less interest in climate mitigation in developing countries. The CDM helped introduce and diffuse mitigation procedures and technologies into these non-mitigating countries, building up their institutional capacity.

CDM helped facilitate the widespread adoption of measurement, reporting, and verification modalities and procedures (MRV, which forms part of the 'transparency' framework under the Paris Agreement - Shishlov, Morel, and Bellassen 2016). An effective MRV system is essential for countries to understand their own GHG emissions and formulate strategies to reduce them, as well as for the creation of domestic market-based instruments such as cap-and-trade. A total of 134 developing countries established national authorities to assess and approve CDM projects (UNFCCC 2014b), which became a boon for global climate policy.

Box 3 The World Bank's role in supporting the KM and A6M

The World Bank has been a major contributor to the development of international carbon markets, including under the Kyoto Protocol and now with the Paris Agreement. Before and during the KM, 'carbon finance' was part of the World Bank's larger response to leveraging development finance towards mitigation and adaptation (World Bank 2006; Alberola and Stephan 2010). Notably, its role included catalyzing the development of a global carbon market through piloting and offering direct support for market-generation through carbon funds.

Under the KP, these funds sought to reduce risks for investors, set social and environmental standards and develop new projects themselves. These carbon funds pool resources, notably from Annex I countries under the KP, in order to generate and procure compliance assets in developing countries. Such initiatives commenced with the Prototype Carbon Fund (PCF) in 1999, and by the end of CP1 had grown to 12 funds and facilities, including the Carbon Partnership Facility (CPF), Forest Carbon Partnership Facility (FCPF), and Community Development Carbon Fund (CDCF). The World Bank progressively assumed multiple roles: catalyzing and developing carbon markets; innovating and developing tools in carbon finance (CF); helping build capacity; and exercising thought leadership and convening power (World Bank 2017c).

More recently, the World Bank has developed other funds to pilot new initiatives and support developing countries to implement effective mitigation policies. This includes the Partnership for Market Readiness (PMR), Carbon Initiative for Development (Ci-Dev), and the Transformative Carbon Asset Facility (TCAF). External factors, notably the creation of the Paris rulebook, will influence the World Bank's future role in continuing to support global climate mitigation efforts by contributing towards the operationalization of the Paris Agreement's Article 6.

CDM may have also helped encourage the adoption of national carbon pricing systems in major host countries like China and India. Both these countries have set up, or intend to set up, their own domestic carbon pricing system. China's own pilot ETS systems have adopted many facets of the CDM while seeking to avoid many of its mistakes (Fialka 2016). The NDRC plays the role of the CDM EB in overseeing the development of project methodologies, of which 173 of the 177 already approved stem directly from CDM (Ecosystem Marketplace 2014). India, which is the second largest issuer of CERs after China and where CDM has been the dominant form of carbon market activity, has set up a market system geared towards enhancing energy efficiency - the first system of its kind in the developing world (I4CE et al. 2015).

The CDM has also helped facilitate learning and experimentation with market mechanisms in developed countries and within multilateral development banks. Japan's Joint Crediting Mechanism (JCM) was explicitly designed to have learned the lessons of the CDM experience, especially relating to additionality. However, unlike CDM, JCM takes a bottom-up approach, in which trade occurs bilaterally between Japan and partner countries The EU's ETS made phased decisions as to which credits (ERUs and CERs) to accept for compliance and experimented with quantity limits. New Zealand's ETS also accepted some limited AAUs and CERs for compliance of regulated entities. The World Bank, which helped create the CDM methodologies and launch the early CDM market (refer to for summary of the Bank's carbon funds during), now runs a number of programs which make use of MRV systems put in place by CDM (World Bank 2016, 94; Cantor, Spors, and Bosi 2010).

Overall, one of the most positive attributes of the Kyoto mechanisms is also one of the least measurable: **they helped spread learning about climate change and the policy instruments used to mitigate it. Speculatively, this diffusion may have supported developing countries' confidence in agreeing to mitigate themselves under the Paris Agreement.**

3.3
Private sector mobilization

CDM helped mobilize the private sector in mitigation projects. As of July 2018, roughly half of CDM projects in the pipeline had data on internal rates of return. These showed that CERs added a median of 3.9 percentage points on to internal rates of return, increasing overall project returns by approximately 59% (UNEP 2018). Though surveys suggest that, in many cases, carbon revenues were not a decisive factor in whether project went ahead ('financial additionality'), CERs are likely to have helped facilitate and mobilize private sector activity overall (Climate Action Network International 2009).

In addition, because carbon finance revenues are performance-based, they incentivize the sustaining of emissions reductions over time—something which may not happen in the absence of revenues (Cantor, Spors, and Bosi 2010). **This enhanced level of engagement and buy-in from the private sector in both developed and developing countries would not have been possible with carbon taxes or direct regulatory measures** (Höhne et al. 2015).

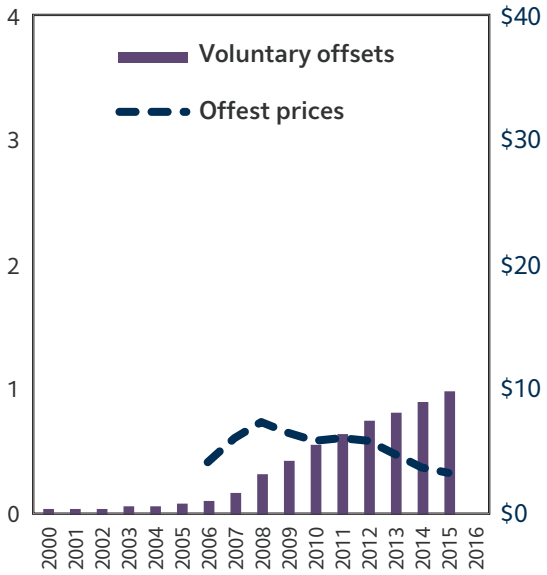
On the demand side, regulated and unregulated entities from Europe, Japan, and New Zealand became more familiar with offsetting through CDM and JI. Regulated entities were variably

allowed to purchase CERs, ERUs, and AAUs for compliance purposes and, in many cases, became active in sourcing units which aligned with their own organizational priorities. In addition, CDM is likely to have helped stimulate the market for voluntary carbon offsets. Companies represent around 99% of the demand for these offsets (Hamilton et al. 2016), and the CMP has encouraged the voluntary cancellation of CERs and other Kyoto carbon assets by companies (Decision 1/CP.21, paragraph 106–UNFCCC 2016).

That said, while CDM was successful at mobilizing the private sector, the promise of a broad and deep carbon market under the Kyoto Protocol was ultimately unfulfilled. The absence of the US, which had been a principal proponent of the market mechanisms, was a major setback. There was nonetheless some excitement among the financial sector of an emerging asset class. Numerous banks and investment funds created or acquired carbon trading operations, many of which were shut down as carbon prices and trading waned. Whether these actors can be brought back into the fold under the auspices of A6M remains to be seen. In addition, it's unclear whether existing CDM projects will continue to sustain emissions reductions given the collapse in CER revenues (average prices were US$0.4/tCO2e in 2015 - World Bank 2016, 37) and monitoring after CP1.

Lastly, the voluntary offset market remained small (Figure 6). Voluntary carbon offsets are project-based credits generated mostly by NGOs and startups in developing countries. The vast majority (99%) of these credits are sold to private companies not covered by compliance markets (such as cap-and-trade) who nonetheless want to reduce their emissions, largely for corporate social responsibility reasons (Hamilton et al. 2016). There are a plethora of informal standards and bodies, such as VCS and Gold Standard, which attest to offset quality. In 2015, offsets worth $278m were traded, covering 84mtCO2e emissions (Hamilton et al. 2016). Although voluntary cancellation has been increasingly encouraged by the UNFCCC (including a new platform for this purpose (including via a new platform for this purpose - UNFCCC 2018b), demand has been sluggish. Given continued low demand and a lack of formal oversight and enforcement, it is questionable whether this market can absorb surplus CERs or have a strong place in mitigation projects under A6M.

Figure 6 Voluntary market volumes and prices



Source: data from Hamilton et al. (2016). Shows cumulative voluntary carbon offsets (left-hand axis, millions) and offset prices (right-hand axis, US$) between 2000-2016. Growth in voluntary offset purchases was steady 2005-2011, but has slowed since, with stagnating prices since 2008.

JI and IET included some limited private sector involvement, but this does not amount to 'mobilization'. Under JI, intermediary companies were involved in the procurement and sale of ERUs. There were many positives that arose from these experiences, notably (as with CDM) the ability of the mechanism to draw from the private sector. That said, some reported irregularities involving these intermediaries contributed to the abandonment of ERUs as compliance units under EU ETS (Aldrich and Koerner 2012). There was also some use of AAUs use by regulated entities in the New Zealand and especially Japanese ETSs, but these direct state-regulated trades were limited in size.

04

What did not work well?

Key negatives of the Kyoto mechanisms include: low demand due to lackluster political will; incomplete coverage; questionable 'flexibility'; information and procedural complexity and opacity; and low uptake from poorer developing countries.

4.1
Low demand due to low political will

The single biggest factor affecting the functioning of the Kyoto market mechanisms was low demand due to low political will.

Market mechanisms work through incentives. For crediting mechanisms, the incentive of carbon revenues allows some projects that would have otherwise been unviable financially to go ahead. For trading mechanisms, a country or regulated entity for whom it is cheaper to purchase allowances compared with mitigating internally should do so, resulting in cost savings. Without meaningful and credible carbon asset prices, there is no incentive to generate new projects or to trade in order to reap cost savings.

However, market mechanisms such as those under the KM are also 'regulated markets'. In effect, carbon markets must be imposed upon jurisdictions by governments. This necessitates the political will to create demand by imposing meaningful carbon prices domestically. Without credible commitment to do so, prices for carbon assets will also not be credible.

Low demand due to low political will blighted the KM, emerging in three main ways. Firstly, the country expected to be the largest purchaser of KM carbon assets (the US) did not ratify the KP. As a result, mitigating countries under the KP accounted for just 21% of global emissions (Figure 1). Though remaining signatories stated their commitment to the KP without the US, with mitigating pledging to nonetheless make use of the KM, the scale of demand was necessarily limited. In addition, it was questionable how committed mitigating countries would be to imposing large carbon prices on their own economies when they only accounted for a fifth of global emissions and (for CDM and JI) were delegating certification authority to outside entities (CDM EB and JISC).

Second, the remaining caps were not binding on mitigating countries. National limits on emissions were set in advance, notably before the US decided not to ratify. Caps had been negotiated, with some Annex I countries (notably the 'Economies-in-Transition' of Eastern Europe) allocated baselines above their expected levels of emissions. This, and prospect of revenues from the future sale of AAUs to the US and other countries, was seen variably as an inducement to entering into the agreement or as a way of compensating for economic losses following the collapse

of the Soviet Union. However, these non-binding caps proved politically durable, with Parties unable to negotiate a reduction in them to reflect the new political reality. As a result, caps on Annex I parties were in aggregate below those of total emissions (Figure 1). Subsequent discussions of 'excess' AAUs and 'hot air' of ERUs became a major point of controversy among KP parties, further undermining commitment to the KP and therefore the KM.

Third, what little political will remained proved vulnerable. Because the US did not ratify the Kyoto Protocol, CDM and JI relied heavily on the EU ETS, which eventually accounted for roughly half of the demand for CERs and ERUs (Ellerman, Marcantonini, and Zaklan 2016). Following the global financial crisis in 2008, there was a surfeit of EU ETS Allowances (EUAs). EUA, CER prices and ERU prices collapsed as a result, as did New Zealand ETS allowances which - because they also accepted CERs for compliance - were linked indirectly to EUAs. The EU was unable to remove surplus EUAs to restore prices due to insufficient political will to impose costs on industries suffering from the economic fallout, with falling prices as a result.[24] Canada's withdrawal from the KP in 2013 and the refusal of Russia and Japan to take on new commitments further underpins the dependence of carbon markets on commitment to the climate regimes they are supposed to support. Following these events, demand, prices, and trade volumes of KM carbon assets could not recover (Figure 2).

Though numerous attempts were made to tweak and adapt the KM, they were not able to overcome the central issue of low demand due to low political will. Without high, consistent, and credible demand, as manifest in meaningful and sustained asset prices, carbon markets cannot function effectively. For CDM, the non-ratification of the US meant demand was concentrated on a small number of entities (notably regulated entities in the EU). The political will underpinning this arrangement, and therefore carbon asset prices, proved vulnerable to events. For JI and IET, high caps among remaining Annex I Parties, and unwillingness to either lower or accept the credibility of those caps, meant demand for ERUs and AAUs would be limited.

4.2
Complexity and opacity

One critique frequently levelled CDM is its complexity and stringency. For example, as concerns over environmental integrity grew, the CDM EB increasingly standardized additionality tests and methodologies, as well becoming stricter enforcers over time (Flues, Michaelowa, and Michaelowa 2008). However, there has been criticism that these tests are subjective, unpredictable, lack clarity, contain loopholes which can be exploited, and were inconsistently applied by the CDM EB (Monceau and Brohé 2011).

One particular bugbear was the various 'additionality' tests. Under CDM, there appeared to be a tradeoff between environmental integrity and complexity: the more complex the tests were the more assurance on additionality but also the more expensive they were to administer (Monceau and Brohé 2011). Though progress was made at streamlining, including through standardizing methodologies, DOEs and project companies found these tests a major burden. For instance, 'financial additionality' tests require that the carbon revenue streams be a decisive factor in whether the project goes ahead or not. This meant there was a 'narrow corridor' within which

projects could be validated: returns on projects could not be too attractive to happen without CDM and not too unattractive that they were unaffordable without these revenues.

However, the majority of financing for CDM projects came from banks. These banks mostly refused to recognize projected carbon finance revenues streams in investment appraisal. This was partly because of the complexity of the market underpinning carbon finance revenue streams, alongside the lack of upfront payments, low demand, and policy uncertainty (refer to section 4.1 above). **As a result of the market's complexity and opacity, CDM projects were tilted towards those that would have happened anyway without carbon revenues.**

Similarly, some have argued that JI and IET were too opaque. For JI track 1, countries could independently convert AAUs to ERUs and sell them through intermediaries. The lack of transparency on this process may have incentivized collusion between states and intermediaries (Spalding-Fecher et al. 2012). For IET, AAU trades are shown in the public International Transactions Log at the UNFCCC. However, this log does not record transactions between countries, show individual account holders or hold details about contracts for forward delivery or options. IET was therefore very opaque, making independent monitoring difficult.

4.3
Low LDC participation

One issue specific to CDM was the low and late participation of LDCs. China and India accounted for 67% of generated CERs. Africa, which has majority of low-income countries,(World Bank 2017b) had a share less than one tenth of that, at 5%.(UNEP 2018) By contrast, between 2003-12 global FDI flows to China and India accounted for 19% of the total to developing countries. Africa's was roughly half that, at 9%.(UNCTAD 2017) **LDCs hosted a lower share of CDM projects than greenfield international investments.**

Part of the disparity is due to high transactions costs and complexity for both project developers and host countries. For developers, upfront costs of to create a CDM project were between US$70,000-$110,00.(Aldrich and Koerner 2012) These high fixed costs make the small-scale projects more prevalent in LDCs less attractive. For countries, hosting CDM required complying with a gamut of MRV, GHG accounting and institutional standards. The emergence of PoAs helped encourage LDC participation, as did the exclusion of non-LDC CERs from the EU's ETS from 2013 onwards. **But the lack of a second commitment period under Kyoto put the brakes on the rising share of LDC CERs.**

4.4
Other incentive issues

While low political will and demand blighted incentives, as reflected in prices of KM carbon assets, other, potentially resolvable weaknesses in incentives existed.

While mitigating countries under the KP accounted for just a fifth of global emissions, the CDM gave

theoretical access to the remaining emissions of non-mitigating countries. In reality, gaps persisted. For instance, for forestry, under the Kyoto mechanisms the 'incentive gap' - defined as the share of carbon sequestration not incentivized by the regulatory framework - has been estimated as high as 88% (Ellison et al. 2013). The mechanisms also failed to incentivize emissions reductions in transportation, carbon capture and storage (CCS) and nuclear energy (AEA 2011). This was partly due to political decisions relating to risk perception and uncertainty around the sustainability of solution, but also because of prices.

In addition, the CDM and JI failed to fully incentivize part of their purpose: sustainable development. Though sustainable development was officially a principal objective of the Kyoto mechanisms, it was not sufficiently incentivized. Notably, there were few, if any, price premiums to be gained from investing in projects with higher sustainable development benefits (Dirix, Peeters, and Sterckx 2016).

While stronger political will may have incentivized exploration into broader coverage of emissions or rewarding of sustainable development, such incentive gaps remained a key weakness of the mechanisms. For CDM in particular, this lacuna likely contributed to its lackluster performance on sustainable development metrics (refer to section 5.2 below).

Lastly, some incentives the Kyoto mechanisms provided to markets and governments were perverse. For governments, allocating excess allowances and allowing them to be sold (AAUs) or converted to project-based credits for sale (ERUs) had the potential to undermine the integrity of the system (refer to Environmental integrity section). These excess allowances may have also created incentives for collusion between companies and specific government officials. Allegedly, the ability of intermediaries to arbitrage between market prices for allowances and the cost to obtain them from governments may have encouraged procurement of allowances at significantly below-market rates (Kollmuss, Schneider, and Zhezherin 2015).

05

What was controversial?

Debate about the Kyoto mechanisms has been heated. Given that the future of ICM and global climate policy at stake, "the tone on all sides in this debate is understandably strong"(Newell 2012). The major controversies concern environmental integrity, development co-benefits, governance, cost-effectiveness, flexibility, and the relationship between carbon finance and climate finance.

5.1 Environmental integrity

A ubiquitous point of contention in discussions about the Kyoto mechanisms is the issue of environmental integrity. The mechanisms had numerous stated purposes, including allowing for flexibility of mitigating countries, increasing participation of non-mitigating countries, sustainable development co-benefits, while backstopping the environmental integrity of the agreement. However, some have argued that KM had resulted in net increases in greenhouse gas emissions, threatening the environmental integrity of the KP itself.

For instance, under a crediting mechanism like CDM, a credit is considered 'additional' if the emissions reduction it represents would not have occurred in the absence of the activity that generates the credit[25] (Kennedy et al. 2016, 2). Because these credits are effectively used as offsets, if the reductions are 'non-additional' then their usage theoretically represents a *net increase* in emissions. This brings into question the environmental integrity of systems that use them. In addition, non-additional credits mean a socially undesirable transfer of value to the issuing entity from governments (for carbon taxes) or regulated entities (in a CAT system with adjustable caps). Lastly, because they are cheaper, non-additional units bring down the price of all other credits, reducing the incentive to mitigate further.

Similarly, for CAT systems such as IET, setting baselines for some countries above expected emissions can result in 'surplus' emissions permits. If these permits are sold to countries that have baselines set below expected emissions (i.e. the cap is binding) then this can also result in a net increase in emissions relative to a situation without trading.

As a result, 'additionality' has been a particularly controversial focal point in discussions of the KM's effect on the environmental integrity of the Kyoto Protocol. This is not surprising. Questions about additionality can never be fully resolved. The counterfactual baseline is unobservable so knowing what 'would have happened' without a particular project is unknowable. That said, issues of environmental integrity are important and warrant consideration, as well as contextualization, within the circumstances of the Kyoto Protocol itself.

While, at face value, IET and JI appear to have a stronger case against them on environmental integrity grounds, this paper argues the opposite.

Firstly, trading under IET had the potential to increase emissions. For reasons discussed above (refer to section 4.1 above) a number of countries, particularly the 'Economies in Transition' (EITs) in Eastern Europe, were allocated AAUs above what they were likely to emit. However, because these excess AAUs did not represent actual emissions reductions critics branded them 'surplus AAUs' or 'hot air'. Allowing countries with binding emissions targets to purchase them potentially prevented these countries from cutting emissions by the same amount. Total trade in AAUs between 2008-2013 was 453m (UNEP 2017 - refer to Figure 2). However, the number of surplus AAUs which could have been made available to trade between 2008-12 was an estimated 8-13 billion (Aldrich and Koerner 2012). This surplus dwarfed the entirety of the CDM and JI markets. The surplus represented up to 6% of mitigating countries' 1990 emissions, whereas these countries were required to reduce their emissions by 5.2% below 1990s levels on average. Further trading of emissions therefore had the potential further undermine emissions reductions of the KP as a whole.

Secondly, and for similar reasons, JI also may have increased emissions. JI was designed to provide flexibility to mitigating countries in meeting their Kyoto obligations. Projects in mitigating countries were supposed to be 'additional' in the sense that they further lowered baseline emissions against business-as-usual. But because countries (under track 1) were allowed to self-regulate, and convert AAUs to ERUs in the process, JI faced the same environmental integrity concerns of IET. One study showed that 600m ERUs, roughly three quarters of all JI offsets, were "unlikely to represent additional emissions reductions" (Kollmuss, Schneider, and Zhezherin 2015). If true, use of these ERUs may have theoretically allowed global GHG emissions to be about 600m tonnes higher than they would have been without JI.

However, both of these issues reflect a weakness of the overall Kyoto Protocol, rather than the IET and JI. Both mechanisms were flexibility instruments available to Annex I countries that adopted absolute emission caps. As a result, the environmental integrity of EIT and JI lied primarily in the stringency of the cap and the effectiveness of MRV rules. For IET, environmental integrity should not have been a concern if the caps were stringent. Likewise, for JI, ERUs, RMUs, and UEAs were all essentially AAUs, and as such additionality would have been less a concern had there been stringent to comply with. The fundamental issue was that the caps themselves were not binding. This was due to two major failures.

Firstly, the allocation of AAUs was used as inducement to bring specific countries into the KP, under pretenses which could not be maintained after it came into force. Secondly, the inflexibility of the caps due to Parties not renegotiating them meant that they remained in force, despite their questionable environmental integrity. A compromise was later formalized under the 'Doha decision' (UNFCCC 2013b), which prevented most surplus AAUs being carried forward into the second commitment period (Kollmuss 2013), but by that point the KP had been sufficiently undermined that Canada withdrew and Japan and Russia refused to take on new commitments.

Both of these issues reflect systemic issues on behalf of the KP itself, rather than the functioning of the mechanisms that supported it. The pretense under which Kyoto was negotiated pre-ratification proved unsustainable afterwards. Despite this, the KP settlement proved inflexible. IET and JI operated in this environment, with caps that were environmentally questionable which they could not address. The controversy over environmental integrity of these two mechanisms therefore reflect weaknesses in the Kyoto Protocol. Specifically, after the non-ratification of the US, the KP included too few mitigating countries, and those remaining were not sufficiently committed to accept the full burden of losses in revenues (net sellers of ERUs and AAUs) or in costs (net purchasers of ERUs and AAUs). Ultimately, IET and JI were not able to (nor were they designed to) overcome this central tension.

However, there is a stronger case against CDM on environmental integrity grounds. A key requirement of the CDM is that emissions reductions should be "real, measurable, [and] additional to any that would occur in the absence" of the project. (Kyoto Protocol, Article 12(5), UNFCCC 1998). To be validated, CDM projects are therefore required to face an 'additionality test'. A number of ways for applying this test have emerged, the primary method being 'barrier analysis' followed by financial additionality tests through 'investment analysis' (Schneider 2009). Weaknesses have been found with both of these approaches, however, notably their subjectivity and the presence of loopholes (Monceau and Brohé 2011), alongside the unpredictability and lack of clarity. As a result, they may have failed to foster 'additional' projects. Through the lack of credibility they conferred on carbon revenues, in some cases they may have even tilted projects towards those that would have happened anyway (discussed in section 4.2 above).

In 2016, a major study on additionality of CDM for the European Union found the vast majority of projects are unlikely to be additional (Cames et al. 2016). Analysis found that 85% of CERs and 73% of the potential 2013-2020 supply of CERs have a low likelihood of being additional and are not over-estimated. Only 2% of projects and 7% of potential CERs have a high likelihood of being additional and are not over-estimated (Cames et al. 2016, 10). Most energy-related (renewables, energy efficiency, and fossil fuel switching), lighting, and cook-stove projects were unlikely to be additional. Perversely, industrial gas and methane projects, which were among the most controversial during the CP1 due to their high concentration in a small number of countries, had the highest likelihood of additionality, followed by biomass projects. Another study finds that almost half of CDM projects may have unlikely or questionable additionality (Monceau and Brohé 2011).

However, even with a large number of non-additional projects like this, the overall mitigation impact of the global CDM portfolio can still remain positive. Conservativeness elsewhere, for instance on baselines and crediting periods shorter than project lifetimes, could theoretically more than make up for the loss of additionality (the same could also be the case for JI projects). In addition, the negatives of questionable CDM additionality should be balanced against the positives of mitigation technology transfer and diffusion that otherwise would not have been transferred (Spalding-Fecher et al. 2012).[26] Unfortunately, such 'knowledge additionality' benefits are difficult to quantify: capacity building projects, for instance, were explicitly restricted from generating credits under CDM for this reason (German Emissions Trading Authority 2016a).

As a result, while many if not most of CDM's projects had questionable additionality, the mechanism contributed to environmental objectives in other ways, notably knowledge spreading. **It is therefore difficult to assess CDM's effect on the environment and the KP's environmental integrity as a whole.**

5.2 Sustainable development and distribution

Another controversial issue, notably for CDM, is the mechanisms' effect on sustainable development. Helping non-mitigating countries achieve sustainable development was a key motivator for the CDM.[27] In exchange for providing mitigating countries with a cheaper way to meet their targets, it was intended that non-mitigating countries would reap sustainable development benefits. These are operationally defined by designated national authorities (DNAs) to include social, economic, and environmental benefits (Spalding-Fecher et al. 2012). In addition, national authorities are required to attest that a project contributes to that host country's sustainable development goals.

However, CDM's record on sustainable development is mixed. It is difficult to fully assess the sustainable development effects of CDM projects: documentation in Project Design Documents (PDDs) tends to be limited, with no *ex post* verification of *ex ante* sustainable development claims. However, there is a large body of literature with supporters and opponents of CDM on sustainable development grounds.

For supporters, CDM has had a positive impact on sustainable development, particularly in employment. One study shows 99% of PDDs reported sustainable development benefits, and found a "clear consensus" within the literature that CDM has delivered social, economic, and environmental benefits (Spalding-Fecher et al. 2012). The strongest effects are for employment, followed by economic growth, air quality, and capacity-building. Renewable energy projects appear to be particularly beneficial, alongside forestry projects, but the evidence is mixed on industrial gas projects. There was no consensus on whether small or large-scale projects are better at promoting sustainable development.

For opponents, while CDM officially had a dual 'mitigation-development' mandate, projects and the institutions that govern them were invariably skewed towards mitigation. One study argues that less than 1% of CDM projects are likely to contribute significantly to sustainable development (Sutter and Parreño 2007). Other studies suggest that CDM projects mostly fail to deliver poverty alleviation, including those supported by the World Bank (Dirix, Peeters, and Sterckx 2016; Michaelowa and Michaelowa 2011). Overall, critics contend that "the evidence is overwhelming that [sustainable development] has not occurred on anything like the scale anticipated" (Newell 2012, 137). In addition, mitigation and sustainable development are not always mutually-reinforcing objectives. Some studies suggest there is a tradeoff between sustainable development and environmental objectives (Alexeew et al. 2010), for instance.

Overall, while there is some evidence of sustainable development benefits from CDM projects, there is strong disagreement on their scale and distribution. **CDM appears to have contributed in some way to sustainable development in host countries, but the effect appears to have been limited.**

For JI and IET, these mechanisms did not have a formal sustainable development rationale underpinning their creation. However, it's important to note that trading mechanisms also have domestic economic consequences, including on firms, governments, and households. This is because they reallocate value within countries (refer to Box 4 for detail). In addition, international trading can have international implications, such as increasing or reducing the risk that regulated entities move polluting activities to places without carbon pricing ('carbon leakage'). Given the capped (albeit lacking stringency and incomplete) scale of the KP, where both IET and JI were

Box 4 The distributional effects of international linkage of mitigation policies

Linking mitigation policies such as carbon markets internationally, such as through IET, JI, and CDM, has numerous distributional effects within participating countries. Linking carbon markets affects the prices of carbon assets, affecting firms, governments, and households in various ways.

For firms and governments, an example carbon market ('A') may have high prices for permits ('compliance assets'), compared with the carbon market of another different jurisdiction ('B'). Trading with the cheaper market should result in a net purchase of B market permits by regulated entities in market A. This suppresses permit prices in market A. This results in net gains for regulated entities, who now face lower compliance costs, with gains greater for more polluting firms relative to cleaner firms. If government overseeing carbon market A auctions permits (rather than freely-allocating them), they will face a loss from lower revenues from auctions. For carbon market B (the net selling market), permit prices rise, and the distributional effect is reversed: polluting firms lose relative to cleaner firms, and a permit-auctioning government could expect greater revenues from future auctions of permits.

For households, the effect is ambiguous for both countries: some households will gain at the expense of others. Distributional effects depend on a number of factors. In the case of permit price rises (such as in market B above), these factors include, inter alia:

- **Development levels**—poor households in rich countries tend to spend a larger portion of their income on polluting goods than poor households in relatively poorer countries (Sterner and Coria 2012). If these goods (e.g. electricity) are produced by domestic regulated entities, assuming some pass-through, permit price rises could disproportionately affect the poor in poorer countries.

- **Factor incomes**—by affecting compliance costs, permit prices can affect factor returns. Factors tend to be disproportionately owned by the wealthy. As a result, permit price rises would be distributionally progressive by predominately affecting upper-income groups (Rausch, Metcalf, and Reilly 2011; Metcalf and Hassett 2012). Permit prices increase should therefore be more progressive in countries with higher concentrations of factor ownership or where capital returns are a small portion of income for the poor.

- **Industrial structure**—regulated entities tend to be in capital-intensive industries. Permit price increases can then cause a shift towards labor-intensive production, potentially creating opportunities for the poor.

- **Government spending** (assuming partial or full auctions of permits)—an increase in government revenues from auctioned permit price rises could affect households depending on how they are used. For instance, increases in social spending, health, and education tend to disproportionately benefit poorer households. By contrast, reductions in capital taxes or deficit reduction tends to benefit wealthier households (Metcalf and Hassett 2012).

Overall, while the effects of international linkage on distribution and poverty effects depend on a variety of factors, linking countries should seek to manage these effects in cases where they are expected to be negative.

between mitigating countries, this did not emerge as a significant issue for the Kyoto mechanisms. **However, given the renewed emphasis under Article 6, SD benefits will become a more salient issue under the Paris mechanisms.**

5.3 Governance

Governance of the Kyoto mechanisms was politically sensitive, for three reasons. Firstly, international linkage invariably presents some challenges to domestic policy autonomy (Ranson and Stavins 2016). Countries will want to ensure that mechanisms are working in their favor, or at least not significantly hindering their policymaking efforts. Conflicts can be expected to arise, for instance, due to the effect of governance policies on the prices of traded carbon assets, and domestic distributional effects (refer to Box 4).

Secondly, there were significant funds at stake for both mitigating and non-mitigating countries. Regulated entities face 'hard' monetary incentives and may therefore lobby their respective governments to suggest or enforce policies in their favor. One study, for instance, finds that CDM EB membership increases the probability of approval of CDM projects in that country (Flues, Michaelowa, and Michaelowa 2008).

Thirdly, the mechanisms were the product of the UNFCCC, where there are both proponents and opponents to market mechanisms. Both were represented on the CDM EB and JISC. Proponents and direct benefactors had a vested interest in the Kyoto mechanism's substantive or perceived success. Because of the political importance of early success to proponents, one could expect scale to be prioritized early on, followed by credibility and legitimacy in the later stages, manifest as increasing stringency of governance over time. There is some evidence of this with CDM EB (Flues, Michaelowa, and Michaelowa 2008).

For these reasons, trading in Kyoto credits and allowances was subject to political as well as market forces on both the demand and supply side. Through project approval and standard-setting, supply was partly dictated by an uncertain aggregation of domestic and international political priorities, as well as the price incentives facing private actors. On the demand-side, preferences for linkage between emissions systems was based on political and cultural factors, as well as economic ones, alongside the low and volatile commitment to the KP (refer to section 4.1 above). For example, it has been suggested that the EU ETSs' barring of CERs from non-LDC countries was partly a geostrategic decision (Ranson and Stavins 2016), and that China was effective at using CDM for its own national priorities (Schroeder 2009).

These political forces are the inevitable facet of multilateral instruments like the KM. But from a private-sector actor perspective, they are also an inherent weakness as they add uncertainty to prices and the discounted cash flows driving investment decisions. Politicization of governance and linkage, as was experienced under CDM, can therefore hinder private sector participation and undermine the integrity of the system. In addition, political lock-in of existing modalities and procedures made the CDM EB process resistant to change.

Lastly, it should be noted that national governance of international mechanisms is not necessarily better than international governance. The ability of countries to generate credits without international oversight was a frequent critique Track 1 (Kollmuss, Schneider, and Zhezherin 2015), and may have provided perverse incentives to governments and firms (refer to section 4.4 above).

5.4 Cost effectiveness

The Kyoto mechanisms were partly intended to help mitigating countries achieve their targets through access to lower-cost abatement opportunities in non-mitigating countries. In economic terms, the marginal costs of abatement vary globally. The optimum policy from an economic perspective would be equalizing the marginal costs of abatement globally, for instance through a carbon price (World Bank 2016). Given that the KP was incomplete, with mitigating countries accounting for just 21% of global emissions, access to lower-cost abatement opportunities in developing countries through the CDM should have substantially reduced the costs of mitigation. In addition, given the heterogeneity in caps and abatement opportunities among mitigating countries, access to compliance assets across borders should have also contributed to lower overall abatement costs.

However, the overall cost saving of the KM appears to have been modest. One study suggests that the Kyoto mechanisms saved Annex I countries was at least $3.6bn in mitigation costs between 2008-12 (Spalding-Fecher et al. 2012). About $2.3bn was in reduced compliance costs for regulated entities purchasing CERs, AAUs, and ERUs under the EU ETS (which accounted for about half of CER purchases), and the Japanese ETS. In addition, governments saved roughly $1.3bn in meeting their national emissions limitation commitments using these units.[28] This latter figure is nontrivial, but nonetheless accounts for less than 0.002% of GDP of the 37 KP mitigating countries over the 2008-12 period (IMF 2018).

That said, savings could have been significantly higher. Firstly, these estimates are likely to be conservative as they exclude the impact of CER availability on EU allowance (EUA) prices, which may have been significant (Spalding-Fecher et al. 2012). Secondly, had EUA prices remained high after 2008 the savings from access to CERs would have been higher, especially if limits on their use were relaxed. Third and most importantly, caps on mitigating countries were not stringent, and became easier to comply with following the financial crash commencing in 2008. Had the caps been more difficult to achieve, and assuming the CDM would have been able to continue to scale, then the KM could have resulted in more cost savings.

5.5 Flexibility

In addition to cost savings, giving countries flexibility in how they meet their emissions targets—both spatially and temporally—was a key rationale behind the Kyoto mechanisms. **However, it's questionable how much flexibility the mechanisms conferred in reality.**

On one hand, the KM allowed for a range of mitigation strategies. These included direct carbon assets purchases and stimulating domestic use of these assets by the private sector (Shishlov, Morel, and Bellassen 2016). A total of 9 mitigating countries took advantage of the flexible mechanisms, suggesting they did offer some flexibility (World Bank 2016). Japan is a notable example. Abatement for Japan is very costly economically: it has a very high marginal abatement cost (MAC) curve (Spalding-Fecher et al. 2012). As a result, Japan anticipated its need for compliance assets to cover its commitments, and steadily acquired AAUs, CERs, and ERUs throughout the first commitment period (Shishlov, Morel, and Bellassen 2016). In addition, the 2011

Box 5 Green Investment Schemes (GIS) and the lessons for Paris

Green Investment Schemes (GIS) emerged as a compromise to the issue of 'surplus AAUs' or 'hot air'. In 2008-12, there was an estimated 8-13 billion (Aldrich and Koerner 2012) in surplus AAUs in Eastern European countries. These could have been used for compliance purposes by other Annex I countries. However, due to concerns about environmental integrity, most other Annex I countries refused to do so. GIS helped facilitate these AAUs in exchange for the agreement that funds would go directly towards mitigation projects, agreed to by the seller and buyer (other governments or private sector entities).

The GIS therefore created a pathway towards opening up the AAU market, while strengthening their environmental integrity through encouraging investments in mitigation. By the end of CP1, approximately 445m GIS-backed AAUs, representing 1.6bn euros, were on the market, the largest share of GIS projects were in energy efficiency and renewables (Tuerk et al. 2013). In addition, they allowed for the front-loading of carbon revenues, which was one of the factors holding back scale in CDM and JI. In the best instances, they also had development co-benefits, positively affecting employment and indirectly supporting state budgets in host countries (through income tax, social security, and other revenues - Karásek and Pavlica 2016).

That said, the GIS also suffered from a lack of transparency. Concerns about environmental integrity were not fully quelled, partly due to the lack of international rules (beyond compliance with KP Art. 17 for transfer of AAUs). As a result of this, and the glut of potential AAUs, buyers of GIS-backed AAUs wielded significant market power, selecting countries and projects in line with their own heterogenous priorities. The most successful selling countries in terms of deals concluded were those with the most transparent rules for monitoring and verification of emissions reductions and financial flows, notably Estonia and the Czech Republic (Tuerk et al. 2013; Karásek and Pavlica 2016). Controversial deals led to some, such as Slovakia, being effectively shut out of the market.

The GIS was a credible attempt at making the best of a bad situation under the loose caps of the KP. Relevant for the Paris Agreement, it also underpins, in an uncapped environment, the importance of buyer power and preferences in determining the source and type of carbon assets. This will likely emerge as an important dynamic with the voluntary participation of Article 6 mechanisms. On the one hand, this is advantageous for environmental integrity as the GIS demonstrated that self-regulation could support work, to the extent that net ITMO-purchasing Parties care about that. On the other hand, heterogenous preferences combined with volatile political will (which were a problem under the KP—refer to section 4.1 above) could lead to very high government-induced policy uncertainty and complexity.

This reinforces the need under Article 6 for transparent frameworks that factor in environmental integrity risks and the need of certainty for the private sector. The bilateral and multilateral agreements that regulate ITMO transfer should therefore seek to underpin certainty over rules, including self-correcting mechanisms where there is low demand and enforcement mechanisms where there is bad behavior. In addition, it underlines the importance of shared responsibility on both sides of an ITMO's trade. To retain goodwill in an uncapped environment, both net suppliers and buyers of mitigation obligations need to care about the environmental integrity of the Paris Agreement, including when prices get high.

Tohuku earthquake forced Japan to use more fossil fuels, making it impossible to meet their Kyoto targets domestically. Japan's ability to meet its Kyoto target despite these issues underpins the utility of flexible mechanisms.

On the other hand, Japan is something of a special case. The caps under the KP were met with relative ease by a majority of countries (Shishlov, Morel, and Bellassen 2016). There was therefore simply no need for most mitigating countries to trade AAUs. Without the incentives provided by more stringent emissions caps, the need for tradeable allowances was low and IET was therefore underutilized - but it was there.

Additionally, project-based mechanisms like CDM and JI appear to be an inflexible source of credits. While there was ultimately an oversupply of CERs due to collapsing demand in the EU and the lack of demand elsewhere, had caps been more stringent and prices higher, there is no guarantee that supply could have met this demand. CDM projects have long lead times. As a result, there was a glut of new CERs well after the collapse in prices. New CERs—notably those from the programmatic approaches—were being generated at precisely the time when they were least needed. It is also plausible that the opposite could have also happened: that too few CERs could have been generated when they were needed. The responsiveness in supply of project-based credits to changes in price may be too slow, and scale too limited, for CDM and JI to be deemed 'flexible'.

Lastly, the mechanisms themselves proved mostly inflexible to changing circumstances. The non-ratification of the US - the largest potential source of demand for Kyoto credits - in 2001 should have been a game changer for the mechanisms. Instead, they were slow to adapt. Assigned unit amounts were left untouched, with the huge surplus of unwanted AAUs holding back the functioning of IET and JI. Tweaks made to JI (through track 2), IET (via Green Investment Schemes, GIS), and CDM (programmatic approaches and methodologies). Some of these offer lessons for the Paris Agreement, notably the GIS (refer to Box 5 above for an assessment of the lessons of GIS for Paris). However, they were mostly piecemeal. In addition, while it became clear that CDM would be limited in scale, countries were unable to agree to expand it to sectoral and policy crediting, sticking to a narrower definition. **This inflexibility should offer a precautionary tale to the Paris mechanisms: under the UNFCCC, risks of 'political lock-in' are large.**

5.6
Crowding out by public climate finance

A final controversy is whether (private) carbon finance was crowded out by (public) climate finance. Broadly, carbon finance and carbon markets seek to utilize the prices mechanism to boost investment in mitigation projects through monetizable carbon assets for emissions reductions such as CERs and ERUs. By contrast, climate finance seeks to leverage public sources finance for direct investment in mitigation projects.[29]

Both carbon markets and climate finance have a common goal: increasing investment in emissions reduction projects. Carbon finance leverages market forces by shifting the incentives faced by the private sector. Climate finance provides direct support for mitigation and

adaptation projects. Because they share the same goal, carbon and public climate finance should supplement each other.

However, under the Kyoto mechanisms, carbon finance and climate finance often did not complement each other. Carbon finance under the CDM, for instance, faced stringent financial additionality testing (refer to section 4.2 above). This meant that CDM was not supposed to support projects that would happened without carbon revenues (Dutschke and Michaelowa 2006). By contrast, climate finance projects are very likely to happen because they are backed by large ODA organizations which would not grant funds otherwise.

As a result, public climate finance tended to crowd-out the private carbon finance offered by CDM. This crowding out of private finance by public finance is the inverse of how the two should ideally interact. Economically, because the private sector tends to be more efficient at allocating capital, it is more desirable that investment be allocated privately. In addition, public funds and ODA are limited. Therefore, from a policymaking perspective, it is preferable that sources of investment be private rather than public. The scale of this crowding out is not clear, as there is little in the literature on this. However, the experience of mechanism participants suggests that the relationship between carbon finance under KM and climate finance was far from symbiotic.

06

What are the lessons for the Paris mechanisms?

Now is the time to reflect deeply on the role of how international linkages of environmental policies generally, and carbon markets specifically, fit into the fight against climate change. The de facto end of the Kyoto Protocol and heralding of the Paris Agreement era creates a rare opportunity for reflection. The stakes for A6M are high, time to achieve the 'well below 2 degrees' target is short, and experience with Kyoto shows how decisions made today at the UNFCCC have a tendency to remain in place well into the future (AEA 2011).

Learning the lessons of experience with carbon markets is crucial at this juncture in international climate policy. This paper offers the following lessons for policymakers designing the Article 6 Mechanisms under the Paris Agreement.

6.1 Embrace the opportunity

Though international carbon markets have detractors, this report contends that there is still a role for them under the Paris Agreement. The case for mitigation is overwhelming, but abatement can be costly. These costs are unevenly distributed worldwide, so it makes sense for some countries to pay others to abate for them. For such transfers to be cost-effective they should be channeled through private agents. This means creating international markets for carbon assets. Carbon revenues provided by these markets can help transfer capital across borders, while increasing the transparency of nationally determined contributions—which remain opaque under the Paris Agreement—and sharing of best practices. In addition, carbon markets can help allay concerns about international competitiveness by equalizing carbon prices between jurisdictions.

Designed properly, policy linkages generally and carbon markets specifically can support, rather than detract from or obfuscate, strong domestic actions from prices instruments (taxes), quantity instruments (CAT systems), prudent regulations, and others. **Experience with Kyoto has shown that linkage can foster learning, transparency and experimentation. These will be crucial for combatting climate change in the coming decades.**

6.2 Define success and failure

One of the problems of the Kyoto mechanisms was pervasive ambiguity. It was not clear what success would look like under the mechanisms. Ambiguities on the purpose and objectives

of the mechanisms held back their effective functioning, especially for JI and CDM (Monceau and Brohé 2011). It is therefore important to define success and failure in order to create a shared understanding both of the A6M's objectives and the risks which could derail them.

Success in the form of a 'good ICM' could look like a series of broad, deep, and liquid carbon markets with a variety of fungible instruments traded at prices supported strong demand. Such a market would be decentralized operationally, with a large variety of linked policy instruments across jurisdictions, but understood centrally through a strong, overarching transparency framework. Risks to the integrity of the system would be known and managed. Prices would be resilient to shocks in economic growth and price crashes in core markets. Funds would flow into countries where abatement actions are cheapest. Developing countries would become more familiar with carbon pricing mechanisms and progressively improve their MRV, accounting, and governance procedures. Sustainable development co-benefits of policies would be understood, quantified, and rewarded. Credits and allowances would be claimed by only one country and reconciled globally. Lastly, and most importantly, **all countries would benefit, with Parties feeling incentivized and empowered to increase their mitigation ambition at the Paris Agreement's next periodic review.**

"Success in the form of a 'good ICM' could look like a series of broad, deep, and liquid carbon markets with a variety of fungible instruments traded at prices supported strong demand."

That said, international linkage of policies such as carbon markets also creates risks to global climate policy. There are numerous issues yet to be hashed out through the UNFCCC process. If this goes badly the Article 6 mechanisms could undermine rather than support the Paris Agreement. Badly-managed mechanisms can undermine environmental integrity, trust and legitimacy.

Failure, such as a 'bad ICM', could look like a mishmash of poorly designed mechanisms and linkages, with a patchwork of ill-defined and opaque accounting and MRV processes. Two or more entities would be able to claim the same carbon assets. Countries with 'soft' baselines, opaque NDCs, or that do not increase their ambition could be rewarded by being able to generate and sell carbon assets. Prospective net providers of carbon assets could refuse to participate given concerns over their own NDCs and continued low levels of concessional finance from developed countries. The market might be opaque and served by questionable intermediary companies engaging exploiting weaknesses and accounting and undermining the governance of developing and emerging market countries. Systemic risks could be poorly understood and shocks can spread quickly through the numerous direct and indirect linkages, negatively impacting domestic policy control. **This bad carbon market would undermine trust and environmental integrity, hold back ambition, and represent a threat to the Paris Agreement as a whole.**

The stakes are therefore high. However, experience with the Kyoto mechanisms offers a potential way forward.

6.3 Support the Paris Agreement

Since the signing of the Kyoto Protocol in 1997 the world has changed, and climate policy with it. Strong, comprehensive and legally-binding multilateral agreements are increasingly

looking like artifacts of the past. There are and will remains political risks to its continuity. But, with its voluntary action, periodic 'pledge-and-review', and weak enforcement mechanisms, the Paris Agreement broadly reflects this new reality. That said, the Paris approach remains untested and, given the history of global climate policy, skepticism is high. But, given it is the approach the world has collectively decided upon, the mechanisms should support the new logic.

Firstly, SDM and the CAs should support the 'stable coalition' of the Paris Agreement by incentivizing and rewarding membership. The biggest weakness of the Kyoto mechanisms was the lack of comprehensiveness in its membership, both in terms of mitigating and ratifying countries. The US was a notable lacuna. As a result, the Kyoto mechanisms faced an uphill battle. Valiant efforts were made by the remaining signatories to ensure their functioning. But, given their over-reliance on the EU and the absence of a major AAU purchaser, US non-participation was a major impediment to their functioning. Paris is different. At time of writing, 179 of 196 Parties had ratified the agreement, including the US (UNFCCC 2018a). Maintaining comprehensiveness of the Paris Agreement is a fundamental objective going forward. The A6M can support this. By offering 'hard incentives' through access to finance, development, cheaper abatement opportunities, and levelling the playing field of international trade the Paris mechanisms can be a force that binds countries together.

Secondly, the purpose of the market mechanisms has changed. Whereas Kyoto mechanisms focused on 'flexibility', the Paris mechanisms should help increase ambition. The main positive of the Kyoto experience is the learning and capacity-building they fostered in developing and transitioning countries. This knowledge had a role in the creation of domestic abatement instruments in key countries. They also may have helped previously-guarded 'non-Annex I' countries from agreeing to mitigate. In the same way, SDM and CA can help developed and developing countries increase their ambition at the periodic reviews (the first scheduled at COP26 in 2020). Such linkages could provide the necessary coordination and momentum-building across jurisdictions to support raised ambition (Mehling, Metcalf, and Stavins 2017b).

For developing countries, mechanisms that incentivize increases in ambition can be devised. For instance, standardized conservative baselines that narrow as NDCs are increased would encourage countries to ramp up ambition and build on previous gains as learning is diffused. More research and analysis on the dynamic incentive effects, and impact on complexity and opacity, are needed.

For developed countries, the mechanisms could be used as a bargaining chip to increase ambition. The EU has banned foreign carbon assets from compliance with its ETS and, post-Paris, has stated that it is not considering reinstating them (European Commission 2017). However, there is some indication that developed countries may use the mechanisms as a means to increase their own NDCs in future periodic reviews. In the run-up to Paris some governments indicated that additional reductions in their mitigation commitments could be achieved by purchasing ICM credits (EDF and IETA 2016). However, judging from concerns about additionality of CERs, ERUs, and AAUs, the EU and other developed Parties are likely to want assurance over both environmental integrity and a pipeline of potential projects before committing to this.

By creating assured supply (by showing the A6M can be operationalized at scale) and demand (from ramped-up developed country NDCs) SDM and the CAs can help increase collective ambition. There is something of a 'chicken-and-egg' problem embedded within the Paris Agreement's ever-increasing ambition logic. For developed countries, where abatement costs are high, the A6M could provide a conduit through which they are willing to commit to ratcheting up their NDCs in future period reviews. However, politically, this may require assurance over future supply. Perversely, and as the KM experience makes clear, supply is itself heavily dependent on future demand. In addition, Parties may be unwilling to increase ambition through the mechanisms without assurance that environmental integrity of the PA will be maintained by their use of A6M. Breaking out of this situation, and allowing for increases in ambition by high-cost countries, necessitates operationalizing the A6M, especially through piloting, as soon as possible.

Thirdly, SDM and the CAs should tolerate variety. The Kyoto mechanisms were centralized, top-down and slow to adapt. As a result, they became too prescriptive and narrow in their definitions of what constituted eligible sources of emissions reductions. Under CDM and JI, policy-crediting was disallowed, linkages between policies were prevented, and potentially cheap emissions reductions from forestry were disincentivized. By contrast, the Paris mechanisms will be decentralized, bottom-up and fast-moving. For CAs in particular there is a vast array of potential different linkages, encompassing different instruments (carbon taxes, CAT systems, regulations, green and white certificates etc.), jurisdictions (multilateral, national, regional, and local), NDCs (historical baselines, business-as-usual baselines, intensity targets and others), as well as other dimensions (refer to Appendix below). **These heterogeneous linkages will be more difficult to understand and monitor. But, in the new logic of the Paris Agreement, they should be tolerated and managed.**

"For Paris, national baselines and international accounting rules are a primary source of risk emanating from Article 6. Getting them right will be crucial."

6.4 Set baselines and accounting adjustment rules carefully

Accounting for emissions reductions through baselines (for CDM) and targets (for IET and JI) were the greatest source of controversy for the Kyoto mechanisms. For CDM, pinpointing the 'correct' baseline for additionality testing was tricky, with an apparent tradeoff between environmental integrity and regulatory complexity. For JI and IET, surplus AAUs were generated as targets were above projected emissions for economies in transition. Some saw this as an inducement to bring these countries into the KP, while some in these countries saw it as compensation for the economic fallout of the end of the Soviet Union. However, surplus AAUs created a major controversy on environmental integrity grounds, while sowing discontent amongst transition economies who felt they had been brought into Kyoto Protocol on a false premise.

For Paris, national baselines and international accounting rules are a primary source of risk emanating from Article 6. Getting them right will be crucial. The context of target and baseline creation is very different for Paris than Kyoto. All countries have voluntary commitments which, it is hoped, will increase in ambition periodically. As a result, a badly designed carbon market could disincentivize increased ambition and undermine the logic of the Paris Agreement. It will therefore be important to standardize baselines, as well as frameworks for assessing and comparing the mitigation and sustainable development effects of climate action.[30]

For NDCs, conversion into quantified multi-year targets will help ensure transparency and inclusiveness of the Paris mechanisms. Analysis suggests that linkages between jurisdictions with different types of NDCs will have varying levels of desirability, risks of double claiming (whereby two or more parties claim a specific emission reduction), and risks of double coverage (where an emission reduction in a country with a GHG target is claimed by a country with a non-GHG target - Kreibich and Obergassel 2016). As a result, some countries could be shut out of the early workings of the mechanism. Low and late participation, especially of LDCs, was a problem under CDM. To allow for a broad participation in SDM and CAs, the NDCs should be clarified as clearly and early as possible, ideally being converted into multi-year targets.

For SDM, baselines should be set in a way that incentivizes future increases in ambition. One approach is to set conservative baselines (as with the Japanese Joint Crediting Mechanism) which narrow as the country increases its ambition. In this way, as the country increases its NDC, the baseline narrows and credits actually increase rather than decrease. This approach has not yet been tested, but is currently being piloted through the World Bank's Transformative Carbon Asset Facility (TCAF).

For the cooperative approaches, defining ITMOs requires balancing breadth (to allow for a variety of linkages) with specificity (to ensure environmental integrity). Multilateral, national, and sub-national jurisdictions have revealed a preference for linking their emissions trading systems. Article 6 creates the opportunity for them to do so in a number of heterogeneous ways (refer to the Appendix below). Some may even expand into larger 'climate clubs', with stricter standards to support deeper linkages and knowledge-transfer (Nordhaus 2015; Keohane, Petsonk, and Hanafi 2015; Zaman and Hedley 2016; Brewer, Derwent, and Błachowicz 2016). At the same time, linkages and the resulting trade in carbon assets need to be transparent to prevent double-counting.

Elaboration is needed of Article 6 which doesn't interfere with jurisdictions' desire to trade ITMOs, but also lays out clear principles of international transparency and accountability. For CA, corresponding adjustments on the international ledger for ITMOs must be done carefully and transparently. For SDM, it is not clear whether it will be a crediting mechanism used for international offsetting purposes, a carbon asset retiring facilit,y or a blend of both. If used for international offsetting purposes, then those transfers must also be carefully accounted for. This is essential for minimizing the risks of double-counting and therefore the environmental integrity of A6M.

6.5
Support meaningful prices with credible and stable commitment

The low demand environment which blighted the KM underpins the importance of credible commitment to the functioning of carbon markets, including those that cross borders. The resulting low and volatile prices facing the private sector were a major problem for the Kyoto mechanisms. Low prices undermined the credibility of carbon revenues, shifting the pipeline of CDM projects towards those with questionable additionality. Uncertainty over policies and prices blunted the incentives faced by market participants. In addition, the collapse in KM asset prices and volumes demonstrates that commitment to carbon markets can be vulnerable to economic and policy shocks.

It is not clear which policies will be linked under cooperative approaches or how the SDM will function. However, to the extent that either relies upon the price mechanism to encourage participation by investors or developers, it is likely that carbon asset prices under the A6M will factor in such policy uncertainty and volatility, reducing incentives for participation. Further, in an uncapped environment such as the Paris Agreement, as compared to the capped environment of the KP, the risks to prices from low demand or a glut of supply are arguably higher.

In addition, government-induced policy uncertainty remains a major impediment investment and innovation globally, including in low-carbon technologies (Stern 2015; Baker, Bloom, and Davis 2015). Reducing this uncertainty should be a principal objective of economic policymakers. Carbon market policies should be consistent, changed only when necessary and, when they are, changed in phases. Policies and systems making use of the Paris mechanisms through linkage should seek to minimize this uncertainty as much as possible. Crucially, doing so requires resilient and sustained political will: there are no 'technical fixes'.

Supporting prices through credible commitment to stable policies should be a major focus in the design, implementation, and monitoring of the Paris mechanisms. 'Safety mechanisms' like price floors and ceilings (to provide assurance to regulated entities on maximum costs) should be explored in the design of linkages and markets. For example, price floors would provide assurance to market participants over minimum costs (for regulated entities), carbon revenues (in the case of project developers), and tax receipts (for governments in the case of revenue-raising measures). 'Safety valve' policies such as this would need require close coordination, as policy linkages tend to propagate design characteristics across borders. Linkages between policies (for A6.2) of participating Parties could therefore contain clauses for transparent coordination of safety valves in order to provide assurance to regulated entities on maximum costs. Other mechanisms for 'auto-correction' in the case of declining demand are also possible. Crucially, such mechanisms would need to be committed to credibly, for instance with commitment to long-term price floors backed up by the force of law.

"'Safety mechanisms' like price floors and ceilings (to provide assurance to regulated entities on maximum costs) should be explored in the design of linkages and markets."

6.6 Maintain collective goodwill

An important lesson from the KM experience is that mechanisms serve as a focal point for Parties. As a result, they can bind countries together, or they can separate them. Much like international trade in goods, trading carbon assets across borders can generate political resistance, and in some cases erode goodwill. Under KP, changing political circumstances left participants with different expectations of what the mechanisms were for. For example, controversies about environmental integrity and the curtailment of demand for ERUs alienated some project developers and Parties, leaving some feeling scapegoated for the shortcomings of the mechanisms and the KP itself. At times, the KM appeared to be a zero-sum game, where one parties' gain was another's loss, rather than a positive-sum game, where all participants can win.

As a 'softer' agreement, building and maintaining collective goodwill while minimizing suspicions will be even more important under the Paris Agreement. Transparency of intention for use of the mechanisms is just as important as clarity over the rules. The A6M should seek to

increase countries' confidence in the Paris Agreement and the level to which other countries are contributing to it. Crucially, an understanding is needed that the principal purpose of the mechanisms is to support the new operating logic of international climate policy. **A6M needs to be, in substance and in form, a positive-sum game.**

6.7
Keep what's valuable from Kyoto, but modify

As well as learning from the mistakes of Kyoto, the Paris mechanisms should retain what is valuable, including much of the institutional setup. The Kyoto mechanisms created wide-ranging national and international systems of MRV, accounting, and methodologies which should be used by the Paris mechanisms. These institutions are valuable, and can help guide some of the major problems facing the CMA. For instance, the large body of knowledge around baseline setting practices developed as part of the CDM can inform baseline setting practices under the Paris mechanisms.

Technical work is also needed to improve them. For instance, methodologies on forestry were too onerous, disincentivizing scaled-up projects (Ellison et al. 2013). Methodologies like this should be overhauled, with particular reference to other approaches that worked better, such as bilateral REDD+ projects.

In addition, the ethic of inclusive international cooperation, including countries opposed to market mechanisms, should be retained. Some countries have been vocal opponents of market mechanisms. However, these countries should not be 'shut out of rooms'. This would be against the spirit of the Paris Agreement and therefore counterproductive. However, given the voluntary nature of the mechanisms, opponents should also not be able to undermine or veto the new approach to linkage agreed under the Paris Agreement. Parties should be free to create linkages in ways that suit their heterogeneous circumstances. Such linkages may evolve from bilateral pairings to mini-lateral 'climate clubs', increasing in scale and benefits for jurisdictions who choose to use them.

6.8
Get governance right

In the short-term, getting the international institutional framework right is a major challenge. Politicization of governance is a risk. For instance, CDM's governance framework may have impeded the mechanism's functioning. Because CDM projects were ultimately approved by the CDM EB, which was subject to the forces of international politics, a significant amount of cost and uncertainty was added to the process. Board membership also predicted the likelihood of project approval. Additionally, because of political lock-in and institutional inertia, changing the functioning of the mechanisms was extremely difficult. These issues are potentially unresolvable.

As a result, a precept applied in creating the transparency and governance framework for A6M should be 'international governance when essential'. The significance of this varies for each mechanism. CA is essentially decentralized, allowing for multiple bottom-up linkages. However, the broad accounting framework for ITMOs needs to be clarified by CMA to ensure environmental

integrity and political credibility of the CAs. SDM is likelyto be overseen by a body which reports to CMA, which could be similar to the CDM EB. This new body's role should be limited to overseeing implementation of the rules of SDM, rather than becoming a policy proposal body in its own right. This would help minimize politicization and uncertainty experienced by some in the CDM registration process, focusing the body on professionalized oversight of Article 6.4.

6.9
Manage systemic risks

The Kyoto system was also volatile and vulnerable due to the dependence of systems on each other. The collapse in the price of EU ETS units affected both CERs and New Zealand ETS units. Under the Paris ICM, the number of linkages - both direct and indirect - will increase in the coming decades and systemic risks could emerge. A collapse in one market, especially a major one, could quickly spread to others, undermining the entire system. This underlines the need for self-correcting mechanisms to be built into the design of markets and linkages.

These systemic risks should be understood by academics, managed by jurisdictions and monitored at the international level. Researchers should leverage recent insights from the literature on networks, complexity theory, and macroprudential policy to understand how to scale, monitor and manage a world of heterogeneous climate policy linkages (see, for example, Hidalgo 2016; Galati and Moessner 2013). Jurisdictions should also manage their own carbon policies and linkages with an understanding of their impact elsewhere. In a linked world, maintaining the objectives of mitigation alongside other domestic policy objectives may increasingly require international coordination.

At the international level, a body could be created charged with prudential oversight of the international carbon market. Its responsibilities could include surveillance, knowledge-sharing and capacity building. It could be part of a larger body charged with global climate policy surveillance: a 'Bretton Woods Climate Institution' (Aldy 2012). This could be entirely independent of the UNFCCC, or independent but accountable to the UNFCCC. This might appear to be a departure from the bottom-up and decentralized approach of the Paris Agreement. However, such a body could be informally embedded within the institutional structure, providing guidance rather than governance over the functioning of A6M. Alternatively, such a framework could be more explicitly incorporated into the design of future 'climate clubs' (Nordhaus 2015; Keohane, Petsonk, and Hanafi 2015; Zaman and Hedley 2016; Brewer, Derwent, and Błachowicz 2016), providing oversight over the mini-lateral carbon market while surveilling the broader international carbon market, and even providing a market-making function: buying and selling carbon assets to counterbalance fluctuations in prices while maintaining liquidity.

6.10
Reward sustainable development

Sustainable development was an afterthought for Kyoto mechanisms. There is evidence that CDM projects had a positive impact on development. But the scale of these effects was limited, varied by project type, and were held back by a lack of incentives to projects with large development co-benefits.

Under Paris, policies and projects under SDM and CAs that help meet sustainable development objectives should be rewarded. Premium pricing for these carbon assets would help ramp up projects and policies with strong mitigation and development benefits but are currently financially unviable.

6.11
Support capacity-building efforts and knowledge sharing

Under Paris, a majority of countries have entered uncharted territory: implementing domestic policies in order to meet international mitigation commitments. The Kyoto mechanisms helped to spread knowledge about climate change and mitigation policies. However, large capacity gaps persist globally.

A big push in international support and cooperation is needed to support countries in meeting their NDCs, including through making use of Article 6. This is especially true given the bottom-up nature of linkages under Article 6. Though there were complaints about their complexity, the Kyoto mechanisms provided a top-down set of modalities and procedures for countries to follow to make use of them. The Paris mechanisms are much more open-ended and bottom-up. As a result, sharing knowledge and experience will be even more important.

Existing efforts to share knowledge of carbon pricing mechanisms, should be expanded, especially where development co-benefits are high. The Partnership for Market Readiness (PMR), for instance, has helped spread knowledge about carbon pricing instruments, their numerous development co-benefits, and the critical MRV infrastructure underpinning them. However, a majority of the 19 implementing PMR countries are middle-income. PMR, or an initiative like it, could be expanded, including a range a broader range of countries, to help facilitate cooperation and transfers of knowledge amongst all countries. For developing countries, this notably includes ramped-up support for carbon taxation, which may be easier to implement than cap-and-trade schemes in a number of developing country contexts, in addition to cap-and-trade, where the client country requests it.

6.12
Encourage symbiosis between carbon markets and climate finance

A broad variety of financing sources are needed to support the global low-carbon transition. Private and public sources of domestic and international climate finance will be needed, alongside the carbon finance revenues provided by linkage. The relationship between these sources was far from symbiotic under the Kyoto mechanisms.

Under the Paris Agreement, public sources should supplement private sources, rather than crowding them out. There are some suggestive models of how this could work. For example, the UK's Green Investment Bank supports syndicated loans to finance largescale domestic emissions reductions investments. It underwrites and funds a portion of the risk, but can be crowded out if enough private financiers are willing to subscribe. In this way, it becomes a match-maker as well as market-maker.

Potential ways forward include using public finance to address market hindering cost-effective allocation across projects and blended finance. Market failures such as information asymmetries may have prevented efficient allocation across CDM projects. This shifted the CDM pipeline towards short-term projects and those with lower sustainable development benefits (Lof 2009). Public funding could be used to correct these market failures, for instance by pre-purchasing credits. This would promote projects with more long-term and sustainable development benefits, prevent crowding out of private finance generally, and help ensure the efficient use of public funds. Another approach is 'blending' of carbon finance with climate finance, to help lower risk for the private sector, while crowding-in rather than crowding-out, private capital (Meltzer 2018). More research is needed in both these areas.

6.13
Generate knowledge of long-standing proposals

While the Kyoto mechanisms helped diffuse knowledge on mitigation and carbon markets, collective knowledge remains inadequate. There are large gaps in policymaking experience on optimal carbon prices, carbon taxation, development co-benefits, heterogeneous linkage, mitigation & compliance valuation, policy crediting, sectoral crediting, and valuation of externalities in varying contexts. Many of these approaches have been discussed for years but there is a dearth of practical experience. A big push is needed to build and share knowledge on how these concepts are operationalized in practice, underpinned by rigorous empirical analysis.

In particular, sectoral and policy crediting has been repeatedly suggested as a way to address a number of the problems of the Kyoto mechanisms. Neither were possible under the Kyoto mechanisms due to the restrictive way that CDM and JI were defined. Sectoral and policy crediting could help address inadequate scale, low participation from LDCs, and additionality concerns (AEA 2011; Figueres 2006; Partnership for Market Readiness 2011). However, it remains unclear whether these approaches could work in practice, with numerous issues to address, notably on baseline setting. Piloting will be crucial for improving nascent understanding of sectoral and policy crediting approaches (refer to Box 2 above for discussion of policy crediting).

Plugging these gaps and sharing the knowledge can help shape the Paris mechanisms towards becoming the 'good carbon market' described above. Volunteers should be enlisted and supported. This knowledge should be shared, for example through fora such as a 'Partnership for Market Linkage', building on the existing Partnership for Market Readiness (PMR 2017).

6.14
Pilot new approaches

Policymakers should also embrace, clarify and test more recent ideas and technologies. A big push is needed to experiment and demonstrate the feasibility of new concepts and approaches under the A6M. This includes ideas from networked carbon markets literature, such as 'carbon buyers clubs', and blockchain technology, in addition to piloting of policy crediting instruments

at the national level (e.g. for carbon pricing—refer to Box 2) and sub-national level (e.g. urban mitigation actions within cities).

Networked carbon markets (NCM) is a mix of approaches which seek to overcome some of the problems of existing carbon markets through potential design improvements (Marcu 2015; World Bank 2017a). For example, carbon assets could entail different exchange rates, thereby reflecting differences in perceived 'quality' of mitigation outcomes. This, it is proposed, can help with some problems of existing carbon markets, such as uncertainties on additionality and linking heterogeneous climate policies and jurisdictions.[32] **That said, these approaches are purely speculative, with no proof of concept or practical examples at present, and face numerous technical, administrative and political obstacles.**

Another recent proposal is 'carbon buyers clubs' (Georg Zachman 2017). These are 'climate clubs' where countries link their mitigation systems internally. Because they sit within the boundaries of the Paris Agreement, but remain separate, they can have more clearly defined and stricter 'gold standard' rules on international emissions trading. This would encourage others that see the benefits of linking into these systems to increase their own standards. These 'carbon buyers clubs' could regulate the quality of imported mitigation outcomes (carbon assets). Domestically regulated entities could be liable to ensure the mitigation value of these carbon assets, as well as being allowed to borrow domestic carbon assets.

Lastly, the emerging financial accounting technology of blockchain offers the prospect of overcoming a number of problems that could arise under A6M (Dodge 2015; Vian 2016; Dong et al. 2018). This includes transparency, double-counting, and incentive issues. For instance, one could envisage a future where regulated entities pay into blockchain-backed smart contracts which automatically execute upon verification of emissions reductions by a decentralized network of 'workers'. However, this technology remains in its infancy, with one known commercial pilot specifically for carbon assets and few established examples beyond cryptocurrencies like Bitcoin.[33]

Clarifying, testing and piloting ideas and technologies such as these could be a worthwhile investment for developing an effective international carbon market that supports the Paris Agreement. **Volunteer countries and organizations are needed to pilot them. The benefits could be large, but resources and appetite for experimentation remain limited.**

6.15
But don't wait to abate

Lastly, though trading of ITMOs may provide numerous benefits in the future, governments should not wait to ambitious implement domestic mitigation policies now. Trading of ITMOs could help achieve the Paris Agreement's objective by raising collective ambition and achieving contributions cost-effectively. However, more importantly, there remains a mismatch between ambition under NDCs and national policies right now. Policymakers should seek to implement domestic mitigation policies, notably carbon taxes or other market-based instruments such as emissions trading systems, in line with their NDCs now. These policies can have numerous

development co-benefits, such as direct improvements in human health and welfare, even before climate benefits are considered (Ian Parry, Chandara Veung, and Dirk Heine 2014).

Though this report offers numerous lessons for a future 'international carbon market', the reality is that this remains speculative. Article 6 has yet to be clarified. Policymakers, academics, and practitioners are still working through what policy linkages are possible and preferable (refer to the Annex below) under Article 6.2, and how the SDM will function under Article 6.4. However, the new paradigm of the Paris Agreement puts the onus onto Parties to define how they want to pursue climate mitigation and adaptation. Countries can choose to voluntarily participate in CA or the SDM. Ultimately, however, it is domestic policies like carbon pricing will allow countries to achieve their NDCs, while also forming the basis of future linkages and cost-saving exchanges of ITMOs.

There may never be a single, specific, 'good' ICM emerging under the Paris Agreement. But, by enacting strong domestic mitigation policies such as carbon taxes or emissions trading systems now, countries can lay the foundation for markets and linkages to support global mitigation efforts. **Policymakers should therefore seek to implement domestic mitigation policies, especially carbon pricing, as soon as possible.**

"By enacting strong domestic mitigation policies such as carbon taxes or emissions trading systems now, countries can lay the foundation for markets and linkages to support global mitigation efforts."

07

Appendix—Varieties of Linkages under the Paris Agreement

For CA, there is a question of which links are possible or preferable given the plethora of different approaches represented in the NDCs. There are three main dimensions of linkage to be considered: NDC type, jurisdiction, and policy instrument (Stavins 2016a).

Firstly, the variety of NDC types (refer to Table 1. Varieties of Nationally-Determined Contributions (NDCs)) adds a new dimension to linkages. Under KP, linkage between emissions systems, tended to be between domestic ETS schemes of Annex I countries and the CDM projects of non-Annex I parties. The EU ETS was a primary demander of CERs generated by CDM projects, which it allowed its domestic firms to use for meeting their own emissions caps. However, under CA linkage will be between countries both presumably bound by their own NDCs. These NDCs are diverse in nature: some are based on a historical baseline, future ('business-as-usual' or 'emissions intensity') baseline, and various non-cap targets like renewable energy and efficiency.

Table 1 Varieties of Nationally-Determined Contributions (NDCs)

Type	Features of NDCs	Number of NDCs	Share of global emissions
GHG targets	Absolute GHG target	43	41%
	GHG target relative to BAU	74	16%
	GHG intensity targets	10	33%
	Other or No GHG target	36	6%
Non-GHG targets	Multiple non-GHG targets	17	32%
	Renewable energy	63	13%
	Energy efficiency	1	0%
	Forestry target	10	2%
Conditionality	Unconditional target	34	68%
	Conditional	49	12%
	Unconditional & conditional	80	16%
Base year	Historic year or fixed level	53	74%
	Projected BAU emissions	79	16%
	Not specified	31	6%
Target year	Single year (other years)	117	89%
	Multiple years	11	1%
	Not specified	35	6%
Carbon markets	Participation in international carbon markets	80	25%
	No participation	17	32%
	Not specified	66	39%
Total NDCs analyzed		**163**	**96**

Source: Mehling, Metcalf & Stavins (2017a)

Secondly, regional and sub-national jurisdictions will increasingly link with each other. There has been a rise of non-state actors linking outside the KP process - particularly in Northern America with the linkages between the California and Quebec ETS. Such links were not possible IET, which was explicitly for nations and economic blocs. Under the Paris Agreement links may be between sub-national jurisdictions rather than national ones.

Thirdly, the policy instruments to be linked will vary enormously. Links between ETSs, carbon taxes, regulations and other instruments like green or white certificates (tradable commodities demonstrating energy generated from renewables or saved from efficiency measures) are all recognizable under CA. Countries are already linking such policies domestically: under Mexico's carbon tax, companies will be allowed to use domestically-generated CERs to meet their tax liability. Such linking internationally is feasible and recognizable with CA.

Beyond these three main dimensions of possible linkage (instrument type, NDC type, jurisdiction) there are others. These include: type of entity affected by the link (public, private or third sector), the level of ambition and effort of each linking country implied by their NDCs, whether either of the NDCs contain an element that is conditional on receipt of climate finance, the coverage of instruments being linked (economy-wide measures or sectoral, for instance), and the level of development between the linking parties.

These different dimensions create vast matrix of possible linkages, which numbers into the millions. Not all of these will be possible: for instance, linking a non-state ETS to a state's ETS where there are constitutional limitations on treaties with non-state jurisdictions. Also, not all will be preferable, given the varying risks to additionality and ambition weighted against the benefits (Kreibich and Obergassel 2016). Jurisdictions have some intrinsic desire to link their emissions systems, revealed by the numerous formal links present outside the Kyoto system (Stavins 2016a). **But it is far from clear which linkages could or should emerge under CA in the post-Paris world.**

Lastly, there are political and administrative realities to contend with. Politically, disputes between participating parties could curtail linkage, while administratively linkage could increase complexity. In recent years that have been a number of different linkages between systems, both inside and outside of the Kyoto Protocol (Bodansky et al. 2015; Mehling, Metcalf, and Stavins 2017a, 2017b). However, there have been a series of aborted attempts to link systems, including between the EU ETS and Australia (due to the abandonment a carbon pricing system following a change in government) and Switzerland (due to disputes over free movement of labor). These experiences, have led some to argue against linking carbon markets entirely (Green 2017).

08

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Endnotes

1. As of May 2018, there was no consensus on the name of mechanism from Article 6.4-7. As one of the more pervasive terms populating the literature and policy discussions, 'Sustainable Development Mechanism' (SDM) is used here.
2. 'Internationally transferred mitigation outcomes' (ITMOs)
3. However, some Parties and stakeholders advocate instead for 'non-market-based approaches' (NMAs). NMAs include regulations and policies such as those promoting the development and transfer of renewable technologies, phasing out of HFCs, and energy efficiency mandates. Article 6.8-9 of the Paris Agreement recognizes "the importance of integrated, holistic and balanced non-market approaches being available to Parties" to meet their NDCs. NMAs are also being discussed within the UNFCCC.
4. Usually 'regulated entities' refers to companies that are subject to a CAT system, such as power plants under the EU's ETS. In the case of an international CAT system like Kyoto, however, it could also refer to governments.
5. In reality, most practitioners use the term 'offsets' to refer to carbon credits generated by baseline-and-credit systems.
6. In technical terms, minimizing aggregate costs of mitigation across an economy entails equalizing marginal abatement costs across firms.
7. A natural market is that which emerges in the absence of regulation, such as trading between companies. A regulated market is one which would not emerge without the intervention of policymakers, the economic rationale for which is to correct a 'market failure'. In the case of climate change, the excessive emission of greenhouse gases beyond what is socially optimal has been called the "the greatest market failure the world has seen" (Stern 2007).
8. The reality is more complex. In principle both CAT and BAC systems can be adjusted to stabilize prices, for example by altering the number of allowances or credits in the system or imposing price ceilings ('safety valves') or floors. If a price ceiling and a price floor are both imposed as the level then the mechanism is equivalent to a tax. In this way, 'carbon pricing' policies such quantity instruments (CAT and BAC systems) and price instruments (carbon taxes) exist on a continuum and can involve a mix of both.
9. 'Parties' refers to signatories of the UN Framework Convention on Climate Change (UNFCCC). As of April 2017, there were 196 Parties to the UNFCCC, comprising 195 countries plus the EU. In this report 'Party' is used interchangeably with 'country' while 'mitigating countries' refers to Annex I countries and 'non-mitigating countries' refer to non-Annex I countries. Not all Annex I countries were mitigating countries under the Kyoto Protocol (Annex B). Belarus and Turkey were not Parties to the UNFCCC when the KP was signed. The US never ratified. Canada ratified but withdrew in 2011. Lastly, because it was based on an old OECD definition, there are discrepancies in the UNFCCC Annex 1 typology and so not all non-Annex I countries can be considered 'developing' today (e.g. South Korea).
10. 'Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol' (CMP, also known as 'COP/MOP'). The Paris Agreement equivalent is the 'Conference of the Parties serving as the meeting of the Parties to the Paris Agreement' (CMA).
11. The 'Activities Implemented Jointly' (AIJ), which arose from COP 1 in Berlin, 1995. The purpose was to build experience and "learning by doing' on mitigation projects. In contrast to JI and CDM, AIJ did not lead to any carbon assets accruing to any country.
12. 'Double counting', as defined by the UNFCCC, includes: 'double claiming', whereby more than one country uses the same ITMO or mitigation outcome towards achieving its NDC; 'double issuance', whereby a country generates more than one ITMO for the same mitigation outcome; 'double registration', whereby the same activity, ITMO, or mitigation outcome is used in multiple mechanisms under A6M, and; 'double use', whereby one country uses an ITMO towards its NDC more than once (UNFCCC 2018c). For an assessment of double counting risk under the Paris Agreement refer to Schneider et. al (2015) and for the A6M refer to German Emissions Trading Authority (German Emissions Trading Authority 2016b).
13. Although in principle Annex I countries with caps and AAU budgets had space for policy linkages of all types by agreeing on corresponding AAU transfers. This has happened under the EU effort sharing Directive for non-ETS sectors and within GIS (Green Investment Schemes), albeit in the latter case only on a project-by-project level.
14. 'Commitment' is a loaded word within the UNFCCC process given the uncertain legal standing of the Paris Agreement domestically for some countries. Here it is used interchangeably with 'contributions' and is not meant to imply that emissions reductions are legally binding.
15. For more detailed discussion of the similarities and differences between the mechanisms refer to: (German Emissions Trading Authority 2016a).

16. Source: UNFCCC (2017) and author's calculations. Total emissions from 36 KP countries (Annex 1 signatories excluding US) was 45.1 gigatons, while world emissions were 220.7 gigatons over this period.

17. The 194 signatories are 193 countries plus the EU. As of July 2018, 179 parties had ratified the Paris Agreement, accounting for 88.7% of global emissions (UNFCCC 2018a).

18. Estimates of CDM's impact on investment vary. In 2013, the CDM EB's annual report stated that CDM had facilitated $315bn worth of capital investments (UNFCCC 2013a). The following year, in its 2014 the CDM EB said CDM had attract "at least US$138bn, probably significantly more" (UNFCCC 2014a). By contrast, in 2015 the World Bank found CDM had supported at total US$90bn worth of emissions reduction projects. This was estimated assuming an investment leverage factor of five, an average nominal CER price of US$11.77 over 2002–11 (weighted by the traded volume), and a total of 1.523 billion CERs issued between 2006–14 (World Bank 2015, 35).

19. As noted in (World Bank 2015), between 2006–14 total renewable energy investments excluding large hydropower projects in developing countries amounted to US$671 billion (REN21 2015, 21).

20. The CDM continues to operate, with some limited interest. However market activity continues to decline and its significance continues to diminish due to the emergence of the Paris Agreement A6M (World Bank and Ecofys 2018).

21. Note however that scale economies could also have been achieved through, and indeed was a principal rationale for, CDM's Programme of Activities.

22. Refer to: Partnership for Market Readiness. (2017). "Establishing Scaled-Up Crediting Program Baselines under the Paris Agreement: Issues and Options." Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/28785.

23. The World Bank is currently piloting a policy and sectoral crediting program called the Transformative Carbon Asset Facility (TCAF), leveraging results-based climate finance (RBCF) worth $2bn (World Bank 2016, 40)

24. At the beginning phase III of ETS in 2013, EUA prices were less than €5 rather than the €30 that had been anticipated by markets in 2008 (Ellerman, Marcantonini, and Zaklan 2016). CER prices dropped even lower than EUAs throughout the first commitment period, and then farther from 2013 due to restrictions in their usage (LDC and non-industrial gas CERs).

25. For an in-depth discussion of additionality, refer to Kennedy et al. (2016).

26. Such 'knowledge additionality' benefits could also apply to JI and GIS projects to host countries (Annex I 'Economies-in-Transition').

27. "The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3." (UNFCCC 1998 Art. 12(2))

28. In practice, it is very difficult to estimate the cost savings of governments from using internationally traded allowances to meet their domestic mitigation commitments. This is because it would require knowledge about the costs of policies that governments would have used to mitigate in the absence of trading.

29. 'Climate finance' is a generic term with numerous definitions. It is often used to refer various sources of finance for low-carbon investments, including public as well as private sources of capital like green bonds for mitigation and adaptation. For instance, at Paris, developed countries recommitted to a pledge to mobilize $100bn in international climate finance each year by 2020 to support developing countries (Australian Department of Foreign Affairs and Trade 2016; OECD 2016). These are to come from a variety of private and public, bilateral, and multilateral sources. Here, however, 'climate finance' refers specifically to public, international sources of finance for mitigation.

30. For example, refer to the World Bank's 'Mitigation Action Assessment Protocol' (MAAP) and the UNDP's 'Climate Action Impact Tool' (CAIT): World Bank. (2018). "Mitigation Action Assessment Protocol." 2018. https://maap.worldbank.org/#/homepage; UNDP. (2018). "UNDP SDG Assessment Tool - Climate Action Impact Tool." 2018. https://climateimpact.undp.org/#!/.

31. As of July 2018, there were 19 implementing country participants were: Argentina, Brazil, Chile, China, Colombia, Costa Rica, India, Indonesia, Jordan, Mexico, Morocco, Peru, South Africa, Sri Lanka, Thailand, Tunisia, Turkey, Ukraine and Vietnam. 15 of these had completed an action plan for designing and piloting market-based instruments for GHG mitigation (PMR 2017)

32. The concept of NCM is being explored and discussed in the UNFCCC's SBSTA in the context of A6M, for instance through discounting of corresponding adjustments (UNFCCC 2018c, 20).

33. For more detail, refer to: Dong, Xiaoqun, Rachel Chi Kiu Mok, Durreh Tabassum, Pierre Guigon, Eduardo Ferreira, Chandra Shekhar Sinha, Neeraj Prasad, et al. 2018. "Blockchain and Emerging Digital Technologies for Enhancing Post-2020 Climate Markets." 124402. The World Bank. http://documents.worldbank.org/curated/en/942981521464296927/Blockchain-and-emerging-digital-technologies-for-enhancing-post-2020-climate-markets.

1818 H Street, NW, Washington, DC 20433 USA
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