Master Thesis

Climate Change: Agreements and Negotiations

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Abstract

An *effective* climate change agreement has not yet been established. The following thesis gives a broad overview of the interdisciplinary topic of climate change, in order to understand why solving global warming remains highly intricate. The thesis tries to link multiple sides to the same problem, and in particular strives to unravel the interconnections between climate politics and economics. It firstly explores the history and future of climate negotiations, and the individual political positions and state formations. A second segment involves an economic analysis: besides discussing policy instruments and appropriate functions in climate economics, a game-theoretical approach towards coalition-building models is given. The second part thus tries to uncover key assumptions used in coalition models, explain free-riding incentives in a repetitive prisoner's dilemma as well as static emissions or abatement games, and depict strategic interactions between countries by presenting current research and its limitations. The thesis thirdly analyses the reasons of failing climate change politics by investigating how climate change is conducted under the currently operating climate framework. It looks into which alternatives might exist, why climate change is said to be malign, and which findings are relevant for future negotiations and research. By the extensive analysis of all contents it is concluded that politics play a major part in determining emission paths. Since politics has not yet been included in climate-economic models, it heavily militates in favour of doing so.

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Contents

List of acronyms

AAU	Assigned Amount Unit
ALBA	Alianza Bolivariana para los Pueblos de Nuestra America
Annex B	all industrialised countries (the North, Annex I/II)
Annex I/II	all industrialised countries (the North, Annex B)
AOSIS	Alliance Of Small Island States
AP	Asymmetric Player
AR	Assessment Report
AWG-KP	Ad Hoc WG on Further Commitments for Annex I parties under the KP
AWG-LCA	Ad Hoc WG on Long-term Cooperative Action under the Convention
BACT	Best Available Control Technology
BASIC	Brazil, South Africa, India, China
CA	Copenhagen Accord
CAT	Cap and Trade (ET)
CBD	Convention on Biological Diversity
CER	Certified Emission Reduction unit
CFC	chlorofluorocarbon
CoP	Conference of the Parties
CT	Carbon Tax
CC	Climate Convention (UNFCCC)
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CMP	Conference of the Meeting Parties
CP	Commitment Period
CSD	Commission on Sustainable Development
C&C	Command and Control
DG	Dynamic Game
DM	Decision Maker
EI	Environmental Index
EID	Environmental Integrity Group
EKC	Environmental Kuznets Curve
ET	Emission Trading (CAT)
EU	European Union
EU-ETS	European Emission Trading Scheme

GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Green House Gas
IAM	Integrated Assessment Model
IEA	International Environmental Agreement (MEA, MEN)
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
JUSSCANNZ	Japan, the US, Switzerland, Canada, Australia, Norway and NZ
KP	Kyoto Protocol
LDC	Least Developed Country
LULUCF	Land Use, Land Use Change and Forestry
MAB	Marginal Abatement Benefit
MAC	Marginal Abatement Cost
MEA	Multilateral Environmental Agreement (IEA, MEN)
MEB	Marginal Emission Benefit (MPB)
MEN	Multilateral Environmental Negotiation (IEA, MEA)
MoP	Meeting of the Parties
MP	Montreal Protocol
MPB	Marginal Pollution Benefit (MEB)
MPD	Marginal Pollution Damage
NAMA	Nationally Appropriate Mitigation Action
NAP	National Allocation Plan
NE	Nash Equilibrium
NGDC	NOAA Geophysical Data Center
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
non-Annex B	all developing and emerging countries (the South, non-Annex I/II)
non-Annex I/II	all developing and emerging countries (the South, non-Annex B)
NZ	New Zealand
ODS	Ozone-Depleting Substance
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of the Petroleum Exporting Countries
PD	Prisoner's Dilemma
QELRO	Quantified Emission Limitation or Reduction Objective
R&D	Research and Development

REDD	Reducing Emissions from Deforestation and Forest Degradation
SG	Static Game
SIDS	Small Island Developing State
SP	Symmetric Player
the North	all industrialised countries (Annex B, Annex I/II)
the South	all developing and emerging countries (non-Annex B, non-Annex I/II)
UK	United Kingdom
UN	United Nations
UNEP	UN Environmental Programme
UNFCCC	UN Framework Convention on Climate Change (CC)
UNCED	UN Conference on Environment and Development
US(A)	United States (of America)
WEA	World Environmental Agency
WEO	World Environmental Organisation
WG	Working Group
WI	Welfare Index
WIPO	World Intellectual Property Organisation
WMO	World Meteorological Organisation
WTO	World Trade Organisation
WWF	World Wide Fund for Nature

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1 Introduction

Climate change is often stated to be the most complicated environmental problem society has ever faced [e.g. Dryzek et al., 2011]. It is also the most malign issue, which means that there exists great asymmetry between countries in terms of development or historical debts, scientific uncertainty about the future damages of global warming, and most importantly, huge political conflict. Therefore it comes as no surprise that an *effective* climate agreement has not yet been established, and total annual greenhouse gas emissions continue rising exponentially. Except for a few EU countries, there are absolutely no significant efforts w.r.t. abatement of greenhouse gas emissions. Climate change affects all countries and thus needs a collective solution. Climate change in this regard is not only about natural sciences, climate economics or environmental law, but is mostly a topic of high and complex international politics showing distinct positions and degrees of willingness to tackle it.

The following thesis gives a broad overview in order to understand why solving climate change remains a highly intricate matter. It tries to link multiple sides to the same problem, and in particular strives to unravel the obvious interconnections between politics and economics.

The thesis is structured as follows: section 2 starts with an intensive investigation of what has happened so far in the negotiation chambers, and on which issues by which set of countries negotiations will focus in the future. Section 3 tries to capture the political positions from the most important actors involved in the climate game by further showing numbers and trends. Section 3 then explores which coalition formations exist under the current climate governance regime. Sections 4 and 5 are chapters which illuminate climate change from an economist's perspective. Section 4 starts by stating what economics should investigate or set value on, and then gives a description of the most important controlling mechanisms (carbon taxes or tradeable emission permits) and explains the flexible mechanisms proposed by the climate regime. Section 4 goes on to capture explanations on modelling payoff functions used in economics associated with the specific structure of the climate public good. Section 5 gives a game-theoretical approach, and starts by discussing key assumptions used in (coalition) models. It then states that the payoff matrix in the climate game might either exhibit total non-cooperation or anti-coordination. Since the prisoner's dilemma better applies to the climate frame, its corresponding repetitive game is investigated and the role of discounting discussed. Section 5 then introduces examples on the static global emissions or abatement game by analysing free-riding, stable coalitions, and coalition sizes. Furthermore, it uncovers strategic interactions between countries and discusses constraints of current models. Section 6 extensively analyses the reasons behind the failing of climate change politics. It first delivers insight into the currently operating framework. By concluding that the architecture is very inefficient and ineffective, it then proposes alternative ways, which consider solutions inside and outside the existing framework, and even complete departures from the current market reasoning. Subsequently, section 6 explores the probably two most interesting parts: why climate change is malign (and ozone is benign), as well as findings (i.e. lessons learned). In this sense the role of science is re-examined and the question which actors incorporate the highest influence on the social perception of climate change is answered. The findings for future negotiations not only address potential improvements inside the current framework, they also illuminate that climate change is not only about climate change, but a thousand things more. Section 7 concludes by discussing future research and relationships between *output*, *outcome*, and *effect*.

2 History and future of climate negotiations

2.1 Timeline of negotiations and agreements

Table 1[1] represents a chronological order of the most important steps in negotiations and achievements in climate politics.[2] Even though climate meetings have especially augmented since the millenium change, raising of environmental awareness started to happen long before. Following the formation of the United Nations at the end of World War II, the first concerns about pollution occurred in the early seventies and resulted in the first UN world conference tackling the human environment. Stockholm 1972 marks the beginning of international environmental politics via the creation of the Environmental Programme (UNEP). The UNEP currently governs six major topics, one of them being climate change with specialisations on adaptation (resilience building to climate change), mitigation (shifting towards low-carbon societies and growth), REDD+

[1] The composition partly relies on Andresen et al. [2012: 3] and Andresen and Boasson [2012: 49].

[2] If not mentioned otherwise, this section relies on Andresen and Boasson [2012].

Table 1: Important years

	event
1945	establishment of the United Nations (UN)
1972	creation of UNEP at the Stockholm Conference on the Human Environment
1986	establishment of the World Wide Fund for Nature (WWF)
1987	adoption of the Montreal Protocol (MP)
	UN-report on "Our Common Future" (Brundtland)
1988	Toronto Conference
	creation of the UN IPCC
1992	Rio Earth Summit, adoption of the Climate Convention (UNFCCC),
	Convention on Biological Diversity (CBD) adopted
1994	into force coming of UNFCCC
1995	CoP 1 hosting to the Convention (Berlin)
1997	adoption of the Kyoto Protocol (KP)
2001	withdrawal of the USA from KP
	Marrakesh Accords - adoption of detailed rules for implementation of KP
2005	entry into force of KP
2007	Bali Roadmap
	IPCC's 4^{th} Assessment Report
	Subprime Crisis
2008	Economic Crisis
	start 1^{st} commitment period (CP I)
2009	Copenhagen Conference
2010	Cancun Agreement
2011	conference in Durban
2012	conference in Doha, end CP I
2013	start CP II
	IPCC's 5^{th} Assessment Report

(reducing emissions from deforestation and forest degradation)[3], as well as an outreach w.r.t. alternatives.[4] The Stockholm conference was also responsible for launching *Earthwatch*, a framework to harmonise and embed monitoring under the UNEP. *World Wide Fund for Nature* was created in the UK the following decade.[5] The formation of WWF happened after the International Union for Conservation of Nature had issued the red list of endangered species;[6] moreover, the Chernobyl disaster happened in the same year, which caused environmental awareness and public health concerns to raise further. WWF is considered to be the first non-governmental organisation (NGO) built with an international ambit. The creation of WWF was a milestone because its success can be assigned to its innovative, collaborative and science-based approach, via local initiatives, strong partnerships, international lobbying and campaigning, aiming to simultaneously solve the decreasing biodiversity and increasing carbon footprint.[7] After the hole in the ozone layer over Antarctica was discovered around 1984, the Montreal Protocol (MP) adoption followed only three years later. In the same year as Montreal, Brundtland issued the UN-report on sustainable development. The report says that the needs of the current generation should be satisfied in a way that does not compromise the needs of the next generation.[8] In 1988, Canada organised the Toronto conference on climate change, where one agreed that the development of a comprehensive architecture on the *law of the atmosphere* was needed [UNFCCC, 2006: 17]. For the first time one agreed on a *global* target since only *global* emissions are important.[9]

In the same year the Intergovernmental Panel on Climate Change, IPCC in short, was established by the UN WMO (World Meteorological Organisation) and the

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[3] See Matsumoto [2012: 49-50] and, regarding the value of forests, Sukhdev via < *http://www.ted.com/talks/pavan_sukhdev_what_s_the_price_of_nature.html* >.

[4] Other topics include disasters and conflicts, ecosystem management, environmental governance, harmful substances, and resource efficiency < *http://www.unep.org/climatechange/* >.

[5] Though, the organisation's roots can be tracked to 1961, i.e. the time when the *World Wildlife Fund* was established.

[6] See < *http://www.iucnredlist.org* >.

[7] See < *http://wwf.panda.org/what_we_do/how_we_work/* >. WWF, however, recently moved from its campaigning position since this position has been filled by Greenpeace.

[8] Economic approaches to sustainability are founded on the main contributions from the early 1970s [Daly, 1974; Hartwick, 1977; Solow, 1974]. Nowadays, green accounting is the main research field, which investigates sustainable development where environmental performance indices try well to act as substitutes to conventional GDP measures [Singh et al., 2009; Smulders, 2008; Stiglitz et al., 2009].

[9] Barrett [2008: 240] notes that the issue with global targets is that they concern *everyone*, which means that they do not concern *anyone* (individually).

UNEP. The IPCC does not undertake research of its own, but assesses peer-reviewed (published) research in order to provide policy-relevant, neutral and unprescribed consensus perspectives.[10] The IPCC entails three subgroups. Working Group I (WG I) studies the science of atmosphere and meteorology; WG II addresses climate change and adaption; WG III deals with implementing emission cutting (mitigation). Those groups undertake assessments in continuous sessions during six years. When finished, the IPCC is reviewed on two stages; the 1^{st} stage via leading scientific experts, the 2^{nd} stage via governmental delegates. That is why it is called the *intergovernmental* panel, which makes the IPCC not a completely scientific body. The entire process regarding problem illustration, evaluation and communication of scientific knowledge is called scientific assessment. I.e. scientific assessments link both fields of science and of politics [Dessler and Parson, 2006: 43],[11] and the IPCC as a scientific body is said to be hybrid representing a *co-body*.[12] The IPCC is much too occupied to undertake both stages meticulously. But the 1^{st} stage tends to go by more smoothly than the 2^{nd} since a summary for decision makers (DMs) is subject to political debate [Andresen and Boasson, 2012: 52]. In the summary for policy makers it can happen that DMs and experts singly agree on the least common denominator [Kohler et al., 2012: 64]. The IPCC has published four assessment reports (AR I in 1990; AR II in 1995; AR III in 2001; AR IV in 2007) so far. Tying in with the failure potential of summaries, AR IV was accused of using wrong predictions (with bias to the top).[13] The *Climate Gate*, i.e. the hacker incident which happened at the University of East Anglia and where documents of the Climactic Research Unit were made public and accused of misconduct (just before the Copenhagen conference), has furthermore contributed to the questioning of climate science and its diligence, and led to the undermining of several IPCC conclusions [Kellow and Boehmer-Christiansen, 2010: xii]. This thus argues for more transparency and access to *open* science, for both the public and research [Cai et al., 2012].

[10] See < *http : //reviewipcc.interacademycouncil.net* >.

[11] Scientific assessments are different from science since they do not perform research based on intrinsically motivated questions, but try to give scientific advice for decision-making. They also differ from politics since they provide answers on positive questions (evidence for happening of climate change, their consequences, etc.) among scientists, not among citizens nor their representatives.

[12] Miller [2001] states that the IPCC marks the connecting pole between the science community and the state parties. Jasanoff [2004] says that a scientific co-body can create new knowledge.

[13] See < *http : //skepticalscience.com/lessons − from − past − climate − predictions − ipcc − ar4 − update.html* >.

Scientific credibility can be achieved by institutionalising expert advice, which exactly marks a *scientific body* such as the IPCC (a *science-policy* institution). Acemoglu and Robinson [2012] state that institutions are very important for nations to succeed, and Kohler et al. [2012: 61-69] refer to the crucial structural and functional variety of scientific bodies. Unfortunately, the IPCC has sometimes lacked credibility as climate scientists have so far in politics and the society (see section 6.3). The next report, AR V, should be due by 2014 and is expected to attract new media attention. Target date is 2013 with a publication of its essential report from WG I.[14]

Moving along the timeline, the Earth Summit has since been considered to be the most promising event of all. Besides all the troubles on the international stage in 1992, the United Nations Conference on Environment and Development (UNCED) gathered in Rio de Janeiro in June of the same year, holding the first global Earth Summit to "promote economic development, reduce poverty, and preserve and protect the earth's ecological systems" [Chasek and Wagner, 2012: 1]. Rio not only pushed towards sustainability, but it embodied the goal of creating global peace, which meant to break the differences between the undeveloped South (i.e. non-Annex B states in Kyoto language, or non-Annex I/II states in UNFCCC language) and the industrialised North (i.e. Annex B or Annex I/II).[15] Rio embraced the participation of NGOs and pushed the establishment of new institutions (e.g. UN Commission for Sustainable Development (CSD)[16]) as well as new treaties like the Convention on Biological Diversity (CBD). Those happenings together contributed to the rebuilding of the key idea of international environmental governance and multilateral environmental negotiations [Chasek and Wagner, 2012: 2]. Regarding the management of tackling increasing CO_2 emissions the most important achievement was, clearly, the adoption of the UN Framework Convention on Climate Change. It entered into effect two years later, in 1994. The Climate Convention (CC or UNFCCC in short) was ratified by virtually every country.[17] Its aim is stated as follows:

[14] See < *http://www.ipcc.ch/activities/activities.shtml#.USzHLqVw1d0* >.

[15] At this point it is convenient to introduce some common terms used in IPCC language < *http://www.ipcc.ch/publications_and_data/publications_and_data_glossary.shtml* >: *South* refers to *developing countries*, and *North* to *developed countries*.

[16] Coalitions under the CSD are the most prominent ones as table 4 suggests.

[17] See < *http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php* >. Note that *ratificiation* means the acknowledgement of a treaty under the domestic law of every state party [Dessler and Parson, 2006: 15].

"(...) stabilisation of greenhouse gas [GHG] concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosytems to adapt naturally to climate change (...)" (according to Article II)[18]

The Convention, moreover, writes an equity principle that developed countries should bear the higher share of damage than developing countries (*common but differentiated responsibilities* according to Article III,[19] and *burden sharing rules* [e.g. Ringius et. al, 2002: 5]). As a framework the UNFCCC is responsible for setting up formal regulations. This means that it urges parties to annually exhibit balance sheets of emissions. Furthermore, it aims for climate-related research to be supported. However, as a framework it does not state any legal obligation for doing so. It merely represents a *soft call* to cut GHGs relative to the 1990-level for industrialised countries [Andresen and Boasson, 2012: 52; Desssler and Parson, 2006: 13].

The first Conference of the Parties (CoP 1) was held in Berlin. Back then, Al Gore was US vice-president. That is why the US together with the EU, which has ever since been a leader in climate change politics, initiated talks on legally binding GHG cuts. Two year later in 1997, at the CoP 3, the KP emerged. The KP *commits* its members (i.e. Annex B states, which voluntarily participate in the KP) by setting internationally binding GHG-emission targets.[20] The KP has been adopted to set out more detailed rules for emission cutting than the convention.[21] It handles, amongst others, commitment levels, emission estimation methodologies, mitigation and adaption, compliance and non-compliance behaviour, technology and resource transfer from the North to the South.[22] It also places a heavier burden on the North by emphasising the common-but-differentiated-responsibility idea. In particular, the KP gives a legally binding upper limit - a target for every party participating in the Kyoto commitment

[18]See < *http://unfccc.int/essential_background/convention/background/items/1353.php* >.

[19]See < *http://unfccc.int/essential_background/convention/background/items/1355.php* >.

[20]A basket of seven GHGs is controlled by the KP. Those are CO_2 (carbon dioxide), CH_4 (methane), N_2O (nitrous oxide), PFCs (perfluorochemicals), HFCs (hydrofluorocarbons), SF_6 (sulphur hexafluoride), NF_3 (nitrogen trifluoride). Water vapour is not controlled by the KP [KP, 2012: 4].

[21]Whilst the UNFCCC does not specify binding GHG quantity targets, the KP does exactly so [Pereira and Jourdain, 2012: 149].

[22]See < *http://unfccc.int/kyoto_protocol/items/2830.php* >.

period.[23] The first commitment period (CP I) lasted from 2008 - 2012 and was binding for all Annex B countries. The overall average target was $\sim -5.2\%$ relative to 1990-levels.[24] However, great variability was allowed between committing parties [Dessler and Parson, 2006: 14]. The particular case of the EU was that it was assigned an overall target (of -8%) and not targets for each single EU member state. During CP I, 37 developed states and the EU Community committed to the aggregate target.[25] The KP, however, is only a tame tiger since it was nothing more than an established middle ground between the North and the South.[26] The South succeeded in not getting any binding targets, while the North, especially the EU, succeeded in proposing legally binding targets. The US, with Bill Clinton as president, drove the allowance of cost-effective, flexible mechanisms and shaped the KP substantially.[27] Allowing non-domestic emission cuts, and thus stimulating green investment or buying oneself free of domestic action, was considered essential for heavy emitters like the US to be able to meet their targets in the first place.[28] The EU did not support flexible (market-based) mechanisms, nor did it support the integration of using carbons sinks like forests for measuring atmospheric CO_2 reduction [Wurzel and Connelly, 2011: 6-8].[29] However, with the benefit of hindsight, these mechanisms are now the most relevant part in the KP, and the EU would not have met its target (for their CP I) if the instruments had not been allowed. Although the US was able to inspire their Kyoto friends to integrate market-based measures, it, on the other hand, criticised the non-participation of the South - especially of India and China. The South was not even politically present. Because of impetuous ratification issues the US Senate opposed a signatory of KP with a vote of 95-0.[30] The reasons behind this included the influence of the fossil fuel lobby groups and concerns of relative gains to China [Vezirgiannidou, 2008: 40-41]. Various flaws surrounded

[23] Refer to $\frac{CPIem.}{baseyr}$ in table 2 and note that targets can either be limitation (e.g. Australia, Iceland and Norway), constant (e.g. Ukraine) or reduction targets (e.g. all others).

[24] The base year is generally expressed as 1990, even though for three out of seven GHGs under Kyoto another base year (1995) can be chosen [Pereira and Jourdain, 2012: 149].

[25] For the CP II participating parties commit to reduce GHGs by -18% compared to 1990-levels (see section 2.2).

[26] The KP nor any other (climate) protocol have produced any real effect so far (see sections 6-7).

[27] Market-based mechanisms are discussed in section 4.1.

[28] See $< http://unfccc.int/kyoto\_protocol/items/2830.php >$.

[29] However, today the EU is the leader in defining and expanding emission trading (ET), the European Emission Trading Scheme (EU-ETS), which is the first and major supranational cap-and-trade (CAT) scheme [Jordan et al., 2010] (see sections 3.1 and 4.1).

[30] See $< http://www.nationalcenter.org/KyotoSenate.html >$.

the KP in 1997 such as unspecified guidelines for how to meet targets and the tenuous possibility of interpreting the protocol differently.[31] Today, there are still many flaws existent in the KP [Barrett, 2008: 241] (see section 6.4). When G.W. Bush became US president in 2000, he immediately opted for a pull out, causing the States to abandon the climate negotiation tables. The EU, in its first attempt, tried to get USA back on board, but failed. Despite being wrathful, it became even more resolute. After the US dropped out (meaning, they have never ratified something remotely close to the KP),[32] the four gang players - Australia, Russia, Japan, Canada (a subgroup of the Umbrella group in table 4) - pushed the previous ideas of the US further. The Marrakesh accords, in 2001, were the result yielding a slightly more detailed frame of KP's flexible mechanisms. But if "it [had] not been for the EU, the KP might not have survived at all" [Andresen and Boasson, 2012: 56], since the other players were always at a threat to leave the negotiations [Pallemaerts and Williams, 2006]. Thus, rather than dying, the KP came into effect [Dessler and Parson, 2006: 163]. At least 55 members, which were responsible for at least 55% of GHGs as of 1990, had to ratify the KP in order for it to *enter into force*, become *legally standing* [Dessler and Parson, 2006: 16], and KP-targets only then became *binding* (the membership rule) [Barrett, 2008: 241].[33] Of the gang of four, only Japan and Canada ratified the KP first.[34] Russia was the key player to ratify the KP. But Russia was and still is an incalculable actor; there were no objections at the time since they already managed to cut GHGs by $> 30\%$ compared to 1990 levels, but they were still hesitating to *ratify* the protocol. Only when the EU did some active lobbying and supported Russian membership to the world trade organisation WTO (side agreements/payments), did it bargain the WTO for putting through the KP [Chasek and Wagner, 2012: 10],[35] Russia was persuaded and gave its vote in late 2004 [Wurzel and Connelly, 2011]. The KP then entered into force in February 2005, which is eight years after its primary adoption, and thus indicates a huge lag as is usually the case

[31] This is different to the MP, where success has been also due to *clear* guidelines how to protect the ozone layer (see section 6.4).

[32] The election of Barack Obama in 2008 has not changed anything to the US status w.r.t. the KP, or stricter climate policy in general, as many hoped for [Skodvin and Andresen, 2009].

[33] Consider Makuch and Pereira [2012] for a definition of terms used in environmental law.

[34] After John Howard was replaced by Kevin Rudd, Australia ratified the KP in 2007.

[35] This shows that side payments enhance joining a treaty (see section 5). Kyoto can further be seen as a system of sidepayments, because by the ET scheme countries such as Russia can be bribed via the possibility of getting profits from selling CO_2 permits, and lax limitation targets. However, the MP allowed many more side payments, which could contribute to its successful participation size (see section 6.4).

in climate politics [Andresen and Boasson, 2012: 57; Dessler and Parson, 2006: 129; Long, 2010: 51; Rogelj et al., 2013]. Developing countries and the US were still not becoming persuaded to join the negotiations. Especially the non-Annex I countries could not be moved because they saw the Annex I failing to cut their emissions and provide sufficient technological and monetary support for them.[36] Although it had no real effect, the KP is still considered a milestone because of its vision of a truly global climate regime.

At the CoP 13 in Bali, some substance was finally given when a roadmap was released. The parties discussed what should be done after the CP I expiry, and the suggested procedure resulted in the Bali Action Plan [Rogeberg et al., 2010]. Most importantly, new negotiation tables, and thus different strands on problem-solving, were opened: Besides the existing AWG-KP (Ad Hoc Working Group on Further Commitments for Annex I parties under the KP), since 2005, the AWG-LCA (Ad Hoc Working Group on Long-term [for the post-2012-period] Cooperative Action under the Convention) was established.[37] Whilst the AWG-KP is set out to discuss stricter targets by amending the KP (e.g. amending the LULUCF (land use, land use change and forestry), agreeing on QELROs (quantified emission limitation or reduction objectives) and on AAUs (assigned amount units)), the AWG-LCA focuses on long-term cooperation between the North and the South for mitigation, adaptation, technological transfer, and capacity building [Pereira and Jourdain, 2012: 154-155]. The South, under the latter track, accepted in this regard so-called NAMAs (nationally appropriate mitigation actions) [Bäckstrand, 2011: 675]. Thus the AWG-LCA also includes non-Kyoto-members (e.g. USA, China, India). In summation, negotiations nowadays focus on four principal things: mitigation, adaption, finance, and technology.[38] Bali was a success because in the same year (2007) global awareness was raised by the issue of the IPCC AR IV, where the climate panel's large media use helped largely.[39] Once again, one was determined to pursue climate change as a ma-

[36]See <http://science.time.com/2012/12/07/the-history-of-global-climate-negotiations-in-83-seconds/>.

[37]See <http://unfccc.int/key_documents/bali_road_map/items/6447.php>.

[38]See Andresen and Boasson [2012: 58] and <http://unfccc.int/2860.php>.

[39]At around the same time Al Gore's movie *An inconvenient truth* was released, and the IPCC together with Al Gore won the Noble Peace Price, which rewarded their efforts for presenting climate change a credible issue and making it visible to society. Moreover, one year before Bali, the *Stern Report on the Economics of Climate Change* was published, which for the very first time put climate change into an economic model of benefits and losses, and built momentum because of its large-scale-assessment character. See Stern et al. [2006], and critical discussions from Nordhaus [2007a] or Weitzman [2007] regarding different discount rates of

jor goal. However, in the same summer the US subprime crisis was in the offing, which then yielded to the global financial crisis destructing entire economies. The major negotiators (US and EU) were virtually absent from the tables. The only positive effect owing to the crisis was that it has curbed consumption, and thus emissions. However, the effect has been rather small so far, and according to the IEA [2011: 3] primary energy consumption in 2010 still increased by 5%, and the atmospheric carbon stock reached a new climax at $\sim$ 400 ppm in May 2013.[40]

The CoP 15, also referred to the fifth Conference of the Meeting Parties (CMP 5), took place in Copenhagen in 2009. The Copenhagen Accord (CA) was set to discuss the CP II, and a specification of the common but differentiated responsibilities under the CC and the KP. Many hoped for a legally binding path for the post-2012-Kyoto-period [ENB, 2009]. But Copenhagen was a disastrous failure. It was a summary of two and a half pages long, which only took *note* of the CA [CA 2009] (the CA was not adopted in consensus and thus represented a non-binding agreement), *noting* that climate change is still a problem by e.g. *recognising* that REDD+ should play a *more crucial role* [see points 6 and 8 in CA, 2009]. Copenhagen thus indicates a clear change from (binding) *top-down* targets to (non-binding) *bottom-up* targets [Pereira and Jourdain, 2012: 156].[41] The delegates *affirmed* that the North should indeed take the higher burden than the South, and that it should "provide adequate, predictable and sustainable financial resources, technology, and capacity-building" [CA, 2009: 1, paragraph 3] to the South, by *noting* the work results from AWG-KP and AWG-LCA [CA, 2009: 1]. The blunt Copenhagen failure came, some say, without surprise. Not only did too many people come (e.g. besides the 120 world leaders, also NGOs

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consumption or future damages (subjective evaluation of climate change impacts), or the low probability / high impact of extreme climate events, which yield to different results when exploring intergenerational problems.

[40]See < *http : //co2now.org* >. This comes from annual total emissions, which today estimate to $\sim$ 10 PgC (GtC) < *http : //cdiac.ornl.gov/ftp/ndp*030/*global*.1751_2008.*ems* >. Note that 2.124 PgC (petagrams of carbon, where 1 Pg = 1 Gigaton (Gt) = 10^{15} g) equal 1 ppm (part/s per million) of CO_2. Note also that 1 kg C $\sim$ 3.67 kg CO_2. Therefore, it holds that 1 PgC $\sim$ 3.67 Gt CO_2. For table 3 this means that e.g. the EU(27) has 4'999 $MtCO_2$ (*emissions p.y.*), which amounts to 4.999 $GtCO_2$ $\sim$ 1.36 PgC, and the fraction $\frac{1.36}{10}$ gives the EU's share (w.r.t. total annual emissions) of 13.6%, which is represented by 10% in table 3 and shows that numbers are not exact. Andresen and Boasson [2012] note that GHG emissions reached 50 GtC (equivalent) in 2012. The inaccuracies might partly be explained that emissions can be expressed as CO_2 or CO_2-*equivalent* emissions, where the latter refers to emissions of other (Kyoto) GHGs expressed in the measure of global warming potential of CO_2.

[41]But regardless of whether all *(national)* (voluntary) pledges at Copenhagen were implemented, it would had not been enough to limit global warming at 2° Celsius [Rogelj et al., 2010].

and the media attended), which the conference had failed to foresee and thus neglected to appropriately prepare for [ENB, 2009],[42] but it made clear the reality that "pretty speeches can take you only so far" [Stiglitz, 2010]. According to Stiglitz [2010], the failure was not the lack of a legal CA, but that there was no common settlement on

> "(...) how to achieve the lofty goal of saving the planet, no agreement about reductions in carbon emissions, no agreement on how to share the burden, and no agreement on help for developing countries."

The deal was brokered among the two brawlers China and the US, and the developing countries South Africa, India, and Brazil.[43] At Copenhagen (and Cancun one year later) the EU together with other countries pledged jointly to provide $ 30 billion in *fast start* finance for the years 2010-2012.[44] AOSIS (alliance of small island states), the African group, and other vulnerable countries, especially the least developed states, pled for stricter GHG cuts and for global warming to be held under 1.5° Celsius until 2100 [Pereira and Jourdain, 2012: 154]. Unsurprisingly, those pleadings were dropped. What was also dropped was the ambition to reduce GHGs by 80% until 2050 relative to 1990. Copenhagen even failed in specifying aggregate targets for the year 2020 [Bäckstrand, 2011: 675; Pereira and Jourdain, 2012: 156]; in general, there were no clear numbers. Poor countries were withdrawn after Copenhagen since it meant for them that they would be locked in their cycle of poverty forever.[45] Poor countries, especially small islands and low-lying coastal regions, which are heavily exposed to climate change plead for aggressive mitigation action. They do not have enough financial resources for climate adaptation either, and Wildavsky's quote "the richer, the safer" [1981] certainly applies. The next year at Cancun (2010), expectations were rather low. But the CA could be brought into the UNFCCC framework [ENB, 2010b]. It was also decided that the planet should not warm more than 2° Celsius [ENB 2010b: 9]. Durban in 2011 decided to hammer out a universal binding agreement "as soon as possible and not later than 2015" (under the Ad Hoc Working Group on the Durban Platform for Enhanced Action), which should come into force by

[42] Transparency and trustbuilding (informal discussions, inclusiveness building) is difficult, and fails when capacity is limited [Davenport et al., 2012: 53].

[43] See BASIC and the US in table 4.

[44] See Stavins and Stowe [2010], < *http://ec.europa.eu/clima/policies/finance/international/index_en.htm* > and section 2.2.

[45] See < *http://www.guardian.co.uk/environment/2009/dec/18/copenhagen-deal* > and Dessler and Parson [2006: 130-131].

2020. The president of the CoP 17 in this regard noted that "what [has been] achieved in Durban will play a central role in saving tomorrow, today", but Andresen and Boasson [2012] or Stiglitz [2010] state that this role will only consist of talks about more talks.[46]

2.2 From Doha onwards

The latest session, the 18^{th} session of the Conference of the Parties (CoP 18) to the UNFCCC, or the eighth session of the CoP serving as the Meeting of Parties to the KP (CoP/MoP 8), has taken place in Qatar. Doha achieved the minimum goal it had set [GW, 2012: 6]. The CoP agreed to extend the KP; a matter the Durban convention prepared last year (CoP 17).[47] If this would not have been agreed upon, there would now be a gap between the CP I and the action plan by 2020 for a global contract. The KP is the only binding agreement to be in force until 2020. The CP II started in the beginning of 2013 and will last until the end of 2020. 37 countries have agreed to bindingly reduce their GHG emissions during the CP II. Although, those countries represent only $< 15\%$ of the global impact of GHGs, which is extremely modest. The targets will be reassessed until 2014. Until 2014, however, countries will continue with the same targets from 2007.[48] Table 2 represents all countries which have committed to the KP in the CP II.

It remains to be said that the KP only takes absolute terms into account. Adjusting it to take population growth and GDP per capita into account would be a step into the right direction, since environmental degradation is not only a product of intensive energy use, but also one of population and economic growth.[49] The countries committing to the extended KP are, besides Switzerland and Liechtenstein, also the 27 EU countries, Australia, Norway, Monaco, Croatia, and Iceland. Canada, Japan, New Zealand, and the Russian Federation pulled out of Kyoto. Canada withdrew from Kyoto in 2011, they did not adhere to their Kyoto target and did not want to risk Kyoto's sanction payments.[50] Further, New Zealand

[46] See $<$ *http://unfccc.int/meetings/durban_nov_2011/meeting/6245.php* $>$ and section 2.2.

[47] The full report on the Doha climate conference with all its details can be found under ENB [2012].

[48] Those are indicated by the column under $\frac{CPIem.}{baseyr}$ in table 2.

[49] Refer to table 3.

[50] See $<$ *http://www.guardian.co.uk/environment/2011/dec/13/canada-withdrawal-*

Table 2: The new Annex-B table to the KP

state	$\frac{CPIem.}{baseyr}$	$\frac{CPIIem.}{baseyr}$	$refyr$	$\frac{CPIIem.}{refyr}$
Australia	108	99.5	2000	98
Belarus		88	1990	NA
Croatia	95	80	NA	NA
Cyprus		80	NA	NA
Hungary	94	80	NA	NA
Iceland	110	80	NA	NA
Kazakhstan		95	1990	95
Liechtenstein	92	84	1990	84
Malta		80	NA	NA
Monaco	92	78	1990	
Norway	101	84	1990	84
Poland	94	80	NA	NA
Switzerland	92	84.2	1990	NA
Ukraine	100	76	1990	NA
♣	92	80	NA	NA
		♣:		
Austria	Belgium	Bulgaria	Czech Republic	Denmark
Estonia	Finland	France	Germany	Greece
Ireland	Italy	Latvia	Litunia	Luxembourg
Netherlands	Portugal	Romania	Slowakia	Slovenia
Spain	Sweden	UK		

details: NA = not applicable; $\frac{CPIem.}{baseyr}$ indicates the quantified emission target for the CP I (2008-12) as a percentage of the base year (e.g. 1990) or period; $\frac{CPIIem.}{baseyr}$ is the same for the (new) CP II (2013-2020); $refyr$ stands for the reference year, which can be used optionally to express the CP-emissions as a fraction of annual emissions (it stands in contrast to the base year, under which targets are legally binding) [KP, 2012]. See in this context conditional and unconditional national pledges in section 3.1 or UNEP [2012: 15-16].

dropped out of fear not to meet their target, which is unfortunate since it had strong policies in house.[51] Why some countries dropped out of Kyoto (e.g. Russia) - Ukraine or Poland intended to but then were persuaded to stay in the CP II - is due to the carry-over-problem. The eastern European countries, in particular, wanted to keep their gains from overreducing in the CP I. They wanted to carry their excess certificates over into the CP II, and to reap profits by selling them via the CAT. This issue is referred to the hot-air-problem since the cost savings from acquiring Russia's excess certificates would in this case be contrived [Dessler and Parson, 2006: 170]. If one takes 1990 as the base year, then the Eastern countries reduced their emissions not because of their abatement efforts, but because the output naturally dropped by itself (i.e. fall of the Soviet Union, which led Eastern countries to become economies in transition), and for the hot-air problem this means that Russia's emissions would not have occurred in any case. Putting it differently, the heavy cuts in GHG emissions were not attributable to (stricter) climate policies but to the choice of the baseyear. At Doha, carrying over certificates has not been allowed because large emitters such as China and USA should not buy excess certificates. By this, China and the USA would not be incentivised to abate emissions at home. There has been an overachievement of the EU-27 regarding meeting their aggregate Kyoto target (of -8%). The EU could overshoot its target and achieved reductions of -17% of emissions compared to the base year 1990. This is because Bulgaria, Romania, Estonia, Latvia, and Lithuania all reduced by approximately 50% w.r.t. their baseyear,[52] so the EU would potentially have had an interest in carrying over their emissions into the CP II. The conclusion w.r.t. EU's overachievement might, nonetheless, be a remarkable one: Kyoto targets might have had an effect overall, at least for the

kyoto − protocol > or < *http : //www.handelsblatt.com/politik/international/klimaschutzab kommen − kanada − beerdigt − kyoto − protokoll/*5951420*.html* >. Canada could withdraw from Kyoto without any costs, because if leaving the Kyoto coalition, the KP foresees no sanctions (see section 6.4). Also, Canada's GHG emissions increased dramatically since 2002 [Pereira and Jourdain, 2012: 149-150], and it received the dubious honour of the the *Award: Fossil of the Year* < *http : //climateactionnetwork.ca/?p* = 26720 >. But Canada's climate efforts are not any different than of Australia or the US (see table 4).

[51] See < *http : //www.nzherald.co.nz/nz/news/article.cfm?c_id* = 1&*objectid* = 10852998 >.

[52] See < *http : //www.eea.europa.eu/data − and − maps/figures/gaps − between − average − total* − 200820132011 > and < *http : //www.bloomberg.com/news/*2012 − 10 − 24*/eu − overshooting − kyoto − emission − reduction − target − by* − 8 − 8 − 1 − *.html* >. This results from data collection where the use of carbon sinks and flexible mechanisms are not taken into account. Also note that commitments are first made by the EU, and then nationally. In the jargon of Kyoto, this is known as *bubble building*, and only the aggregate bubble matters. Inside the bubble, however, targets can be over- or underachieved.

EU. For climate actors which did not meet their CP-I-targets and which cannot be seen as hot-air-players, the question arises why they committed to the CP II at all. As in the case of Switzerland and other Scandinavian countries, it likely lies in their political commitment to abate climate change. Germany is an interesting *green* country (besides the UK), as well.[53] It has initialised visionary projects like *Desertec* and massively invested into renewables like no other country [Wurzel and Connelly, 2011].[54] Germany, furthermore, adopted a limitation target of -40% by 2020 (relative to 1990) and it is the only Annex I state under an *unconditional* target, which the IPCC [2007a] recommends (i.e. 25-40%). Such determined behaviour can only be understood by analysing national politics and policy shaping [Christoff and Eckersley, 2011: 442].

Further, since 2012 emission standards have gained importance.[55] For example, there will be CO_2 performance standards in the EU for new passenger cars. Since 1995, emissions from cars have gradually declined from 185 gallons/km to 135 g/km in 2011.[56] The 2015 target, however, is even 130 g/km ($\sim$ 4.9 l/100km),[57] and the 2020 target is 95 g/km ($\sim$ 3.6 l/100km).[58]

At the CoP 18 climate change has been mentioned in the context of *loss and damages* and that someone has to pay for the damage caused.[59] The FCCC [2012: 23] "requests developed country parties to provide developing parties with finance, technology, and capacity-building (...) [and] decides to establish (...) institutional arrangements, such as an international mechanisms (...) to address loss and damage associated with the impacts of climate change in developing countries that are particularly vulnerable to the adverse effects of climate change

[53] The EU exhibits a leadership role thanks to major abatement efforts of Germany and the UK (see section 3.1). Although, both countries (also) met the EU target for the CP I by historical accident, Germany met it because of its diminishing East German Block, and the UK met it because of a privatisation of the electricity sector and decreasing subsidies for coal-related goods [Dessler and Parson, 2006: 13].

[54] See < *http : //www.desertec.org/de/* >.

[55] See section 4.1. and < *http : //www.bfe.admin.ch/themen/*00507/05318/?*lang* = *en* >.

[56] Note that 1 US gallon per km $\sim$ 3.8 liter per km.

[57] Germany, because of its successfull car industry, refused to introduce a 120 g/km-target for 2015.

[58] For all details see < *http : //ec.europa.eu/clima/policies/transport/vehicles/cars/faq_en.htm* >.

[59] Talks on this have been initiated at the Cancun conference < *http : //unfccc.int/adaptation/cancun_adaptation_framework/loss_and_damage/items/*6056.*php* > and developed at Doha. Because the North wants the South to adapt to climate change but the South opposes adaption because the North is to be blamed for global warming, the idea of attributing liability to the polluter (the North) might work, as the South gets compensated for the damage caused by the North.

(...)". The issue of loss and damage deals with the loss of agricultural land or area because of rising sea levels. Another example to provide damage compensation would entail the resettlement of small island countries such as Tuwalu.[60]

The AWG-LCA (the subsidiary body of the UNFCCC) [e.g. Dessler and Parson, 2006: 192] has finished the *general* negotiations.[61] From 2013-2015 the AWG-LCA now has time to hammer out an agreement (to be concluded by 2015),[62] which shall be more effective than the KP and thus should enhance *implementation* of the UNFCCC. The action-framework (the global climate contract) shall come into force by 2020. The founding architecture of the global 2020-contract will be the Kyoto framework, since the Kyoto has established fairly comprehensive rules on how to calculate emissions, which climate projects are to be accredited (clean development mechanisms (CDMs)), and how forest protection should be handled. But since international effort is built upon national action (strong free-riding incentives) the 2015 agreement for 2020 is doomed to failure, and some believe there will never be a global contract.[63] Poor countries, if they are not like the Maldives or Bangladesh, which are especially climatically vulnerable, have priorities other than environmental protection, and such countries (e.g. India, China) are primarily interested in raising their industrial production or lowering their degree of poverty. Thus, there would occur opportunity costs, even though they are only short-term. The conservation of the environment for some actors of the South is not considered to give the same amount of benefit compared to the amount it gives to the North. Also, Northern countries (e.g. the US) are unlikely to commit to some global contract if they are not even willing to ratify the KP, nor to participate in a CP above all (see table 2).[64]

Furthermore, as green finance has been rather low up to now,[65] $ 100 billion per

[60] See < *http://blogs.ethz.ch/klimablog/2012/12/12/gehort-und-gesehen-am-un-klimagipfel/* >.

[61] See < *http://unfccc.int/meetings/doha_nov_2012/session/7054.php* >.

[62] Even though, emission growth should be reversed by 2015 (i.e. abatement costs are cheaper than e.g. in 2020 since with more time passing, abatement gets more expensive) [IPCC, 2007a], there are absolutely no indications of a slight chance of possibility for a slow-down [Rogeberg et al., 2010] given the recent trends. Emissions are growing with a speed, which the IPPC [2007] predicted in the worst-case scenarios < *http://www.ipcc-data.org/sres/ddc_sres_emissions.html* >.

[63] See < *http://www.economist.com/news/international/21568355-no-progress-today-slightly-better-chance-progress-tomorrow-what-doha-did* >.

[64] Establishing a global contract will be difficult because climate change is a very malign environmental problem (see section 6.3).

[65] Under the KP three funds were created: the Special Climate Change Fund, the LDCs Fund

year shall be given to developing countries by 2020 via the help of the Copenhagen Green Climate Fund (GCF) and a Technology Mechanism [Andresen and Boasson, 2012: 54].[66] For short-term climate finance until 2015, the North is *encouraged* to give at least the sum they have given so far. The United Kingdom of Great Britain and Northern Ireland, Sweden, Denmark, and Germany, and some other EU states have agreed to create new fundings, in addition with their old commitments, in the range of $ 6 billion for 2013 and 2014 [Andresen and Boasson, 2012: 54].[67] The GCF is raised by developed countries and is meant to have two desirable functions:[68] The first includes mitigation financing in developing states (e.g. finance insurance because promises and money mean action; no money means no action), and the second includes the possibility to adapt to climate change (e.g. tides and floodstorms). The idea of the GCF is to make the developing countries agree on a more restrictive framework after 2020. Thus, addressing the needs of the South beforehand seems most important, because the South wants to be compensated for the damage the North caused. At the next conference (CoP 19), which will take place in Eastern Europe at the end of 2013, the North is going to propose strategies for mobilising a scaled-up finance form for the GCF.[69]

Future negotiations will, furthermore, involve the review of the long-term aim to keep global warming $\leq 2°$ Celsius. This reassessment is beginning in 2013 and planned to be concluded by 2015.[70] What could happen at this point is that policy makers and politicians take the *easiest* solution and adjust the target to 4° Celsius.[71] To prevent such an adjustment what could be considered is the

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(Least Developed Countries Fund), and the Kyoto Adaptation Fund [Pereira and Jourdain, 2012: 153].

[66] These pots of money have been raised under the Kyoto regime during the Cancun negotiations in 2010 < *http://unfccc.int/cooperation_and_support/financial_mechanism/green_climate_fund/items/5869.php* >. Unfortunately, no detailed information has been provided of the financial sources nor a detailed concept of this fund [Pereira and Jourdain, 2012: 157].

[67] See < *http://ec.europa.eu/clima/policies/finance/international/index_en.htm* > and < *http://www.wri.org/publication/summary-of-developed-country-fast-start-climate-finance-pledges* >.

[68] See < *http://unfccc.int/cooperation_and_support/financial_mechanism/green_climate_fund/items/5869.php* >.

[69] See < *http://unfccc.int/cooperation_and_support/financial_mechanism/green_climate_fund/items/5869.php* >.

[70] See < *http://unfccc.int/key_steps/cancun_agreements/items/6132.php* >.

[71] See < *http://germanwatch.org/de/5922* > and < *http://blogs.ethz.ch/klimablog/2012/11/27/immer-noch-nicht-auf-dem-weg-zum-2-grad-ziel/* >. Consider in this context also Rogelj et al. [2012] for climate simulation models.

inclusion of other sectors, like air traffic, to be subject to emission reduction aims. But this is not enough, and people have started imagining a world, which is 4° Celsius warmer.[72] WB [2012] presents an ugly picture, in which by 2100, sea levels would rise up to 1 m, 75% of tropical forest area would diminish and thus accelerate climate change by positive feedback effects (i.e. less terrestrial carbon sinks which act as global public goods via carbon sequestration [Stiglitz, 2010]), and extreme climate events like droughts and floodings would happen more often. Therefore, a 4° Celsius warmer world must be avoided.

As Kyoto has not produced any real effect so far, what is needed for the latter is a new global contract after 2020, which would include the US, China, India, and Brazil, as well as the rejoinment of Japan and Russia. This will be especially difficult since e.g. the US and China are more interested in executing their *own* climate agenda, outside the UNFCCC (see sections 3.1, 5.4, and 6.2).

3 Individual positions and political coalitions

3.1 Positions of key climate actors

In the following paragraphs a compact description of climate positions from the most crucial actors is pursued.

European Union: [73]

Not all developed countries that belong to the class of "most responsible, strongest capacity and not especially vulnerable" [Christoff and Eckersley, 2011: 439] have welcomed their leadership obligations.[74] Two countries lead the EU (and even the entire Annex I block): Germany and the UK.[75]

In contrast to the ozone-layer-depletion diplomacy, where the EU had acted as a laggard and only had been swept along by the leading US, it has determined

[72] See < *http://www.economist.com/news/*21567342 – *after – three – failures – years – un – climate – summit – has – only – modest – aims – theatre – absurd* >.

[73] If not mentioned otherwise, this paragraph is based on Helm [2009].

[74] The Umbrella Group (see table 4) has certainly not.

[75] Christoff and Eckersley [2011: 444] give political structures as possible leadership reasons. The UK, on one hand, is a uniformly built state, and votings occur via the winner-takes-all principle. It has an insignificant green party, but high interest-group policy-making and interposition. Germany, on the other hand, is a federal state, with a relative majority voting system. It has a strong green party, but exhibits a corporatist policy-making and interest-group interposition.

itself to combat climate change [Damro and MacKenzie, 2008]. It learned that an EU-approach is better than a national-country one because unified, it radiates an atmosphere of power [Helm, 2009: 244]. It took the EU rather long to dedicate itself to climate change [Wurzel and Connelly, 2011: 4-5]. The first phase (formation and formulation phase) started around the late 1980s and lasted until 1992 when the EU committed to stabilising GHG emissions by 2000.[76] The EU emerged from a latecomer to a Kyoto leader (during the second phase of KP negotiations and the third phase, also known as KP rescue phase from 2001 - 2005), even though major climate powers stood aside (i.e. the EU decided to pursue the KP despite the refusal coming from the US), and there were several reasons for this isolated transition [Wurzel and Connelly, 2011]. The Kyoto average target of -8% for the CP I could be achieved with little to no pain since the collapse of the Soviet Union meant that production slowed down (and Kyoto targets were fortunately formulated as production targets (which they still are)). Initially, the EU wanted to reduce -15% if other OECD states did so, too [Barrett, 2008: 241]. This represents a usual failure point of *conditional* pledges, which are contingent on the behaviour of other actors. Financial transfers from North to South were not integrated in Kyoto and that is why the EU did not have to pay substantial monetary amounts. Ultimately, with the formation of the EU in 1992, new across-border coalitions became increasingly important and gave green voters a broader political stage, which could be backed up by major lobby groups. In particular, the UK turned to self-proclaimed worldwide leadership, Germany had a strong Green Party, and France had nuclear power. Having established a leader position, the EU finds itself in the fourth phase, which involves the KP implementation and a follow-up framework. The fourth phase has been active since 2005, since the date when the EU-ETS entered into operation and where permits were grandfathered (as the industry expected for achieving strategic profits). Besides supporting the Kyoto framework, the EU also promoted the EU-ETS and the use of renewables. Both were essential for shaping the EU climate and energy package in 2008 after the Bali conference. The EU is committed to unilaterally lower its GHGs to a minimum of 20% under 1990-levels (which represents the *unconditional* pledge),[77] raise renewables to 20%, and improve energy efficiency

[76]Most notably, Margaret Thatcher and Tony Blair, both British ex-premiers, first campaigned for abating GHG emissions. In the early 1990s, the EU wanted to follow the route of a CT, but only the british experiment to pursue a CAT was proved of value.

[77]The conditional plege implies a reduction of 30% by 2020 only if the US and other developed countries agree on a similar target [UNEP, 2012: 15]. The EU should have taken the conditional

to 20% by 2020 (the *20-20-20* targets for 2020). The EU climate and energy package, furthermore, involves a deeper commitment to a low-carbon economy, expanding promotion for *green* growth and jobs, a reform of the EU-ETS, national targets for non-EU-ETS emissions, national renewable energy targets, and carbon capture and storage (CCS).[78] In the same year of 2008 it was agreed that the EU-ETS should also involve limits on GHGs emitted by airplanes and cars, and the CAT be revised accordingly in the period 2013 - 2020 [Wurzel and Connelly, 2011]. In general, most EU policies developed so far have largely been a *trial*, and have mainly resulted from intervention learning. Some say [e.g. Helm, 2009], the EU-ETS was the political result of a thrill for market mechanisms at the time, and the realisation that there had to be put a price on carbon, as well as the lobbying from the private sector for a CAT (if certificates were grandfathered) instead of a CT. Also, the policy process emphasised the income effect, i.e. the question about who gets the money under each economic instrument. Under a CT scheme the money goes to governments, and under a CAT scheme the money stays within the private firms (if permits are grandfathered) [Helm, 2009: 230]. That is why a revision especially needs to be made for the European CAT-scheme. A first success towards remodelling happened in 2012, when the international air traffic became part of the EU-ETS.[79] The EU entered the CP II with another main innovation besides the expansion of the permit domain; most permits are now given away in a (non-free) auction.[80]

Climate change is a global problem and, even though richer countries should abate more, it is not important *where* emission abatement occurs [Hepburn and Stern, 2008]. The EU might not be the perfect location to achieve these targets [Helm, 2009: 227]. There are much cheaper paths such as the preservation of tropical rainforests or a decarbonisation of China's and India's coal economy, which exhibits rapid growth (i.e. EU non-internal GHG cuts, possibly within the CDM scheme).[81] In summation, the EU has ever since tried to be a leader but, partly

pledge as its unconditional pledge, since to bindingly reduce GHGs by 20% seems rather low, especially if bearing the overachievement during the CP I in mind.

[78]See < *http : //ec.europa.eu/clima/policies/package/index_en.htm* >. The package is flawed, and packages always need further reassessments since they are built upon political processes; the $20-20-20$ targets sound too fancy and are barely efficient. The target for renewables (if it wants to be achieved), will cost very much, and the target for efficiency is expressed as a common target instead of a localised target.

[79]See < *http : //blogs.ethz.ch/klimablog/2012/07/19/flugverkehr − freiwillig − kompensieren − trotz − eu − ets/* >.

[80]See < *http : //ec.europa.eu/clima/policies/ets/index_en.htm* >.

[81]However, one should bear in mind that non-internal CO_2 reductions (e.g. CDM projects)

because it has been too involved with inland policy development, has failed in persuading other key climate actors of a similar ambition.

The United States: [82]

The USA has never ratified the KP. It does not have any unconditional pledge, and emissions growth is going to be business as usual [UNEP, 2012: 16].[83] Savings being low and budget deficits being high have affected the US trade deficit. And it comes as no surprise that the US is living beyond a healthy carbon footprint, since is also has long been living beyond its actual economic income. The Obama administration's promise to implement a CAT-bill died in 2010 because of opposition by the US congress and there is a large refusal to adopt a Kyoto ET scheme.[84] The problem with the US (as a developed country) is that if it does not commit to higher abatement efforts, the South (especially China and India) will not commit, either. The US as a state party arrived at Copenhagen with a pledge of only 4% as a reduction target w.r.t. 1990-levels [Andresen and Boasson, 2012: 63-66], and it still holds to the argument that it will not commit if the South does not show any efforts.[85] Analysts say that US pledges are definitely not sufficient to keep warming under 2° Celsius. But the US will not, or is not likely to, strengthen its forces to abate climate change, at least not in the short-term [Andresen and Boasson, 2012: 63-66].[86] However, neither will developed countries such as Canada or Australia. All three behave as laggards [Christoff and Eckersley, 2011: 438], even though Australia managed to implement a carbon tax in 2012 and participates in the CP II.

Emissions power often shapes bargaining power, and thus, via international legitimacy, the entire climate regime. Most often, representations can be traced back to national interests. For climate laggards this means that (ceteris paribus)

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lower domestic green innovation incentives (see section 4.1).

[82] If not mentioned otherwise, this paragraph is based on Stavins [2008].

[83] However, its conditional pledge implies a reduction of 17% below 2005 by 2020.

[84] See < *http://www.bloomberg.com/news/*2012 − 10 − 25/*cap − and − trade − failure − aided − u − s − to − cut − carbon − emissions.html* >.

[85] But again, why should China participate in the CP II if the US does not? The Rio Summit in June 2012 further showed that developing countries will only commit if the North delivers evidence of abatement efforts (and thus higher reduction targets) since the North should clear its (historical) debt first < *http://www.guardian.co.uk/environment/rio* − 20 − *earth − summit* >.

[86] Since the Bush era its argument involves that abatement comes with higher opportunity costs; an argument, which Canada, too, presented during its Kyoto withdrawal (see section 2.2).

abatement costs are rather high, which, in turn, are defined by high fossil fuel dependence or high costs for *green* amendments [Christoff and Eckersley, 2011: 438-439/442]. Even though Australia is more vulnerable to climate change than Canada and the US, this same condition does not prevent it from behaving as a laggard. But high fossil fuel dependency does not determine a state's non-leadership role in climate negotiations. A good example is Germany, which originally depended on coal, but nonetheless evolved to become a leader [Christoff and Eckersley, 2011: 442].

It needs to be said that the US is not a *monolithic* block of laggards (e.g. California is different in terms of green awareness than Texas), and subnational climate change policies are interesting behind a background of uncertain national commitment (top-down) and federal political systems. Although bottom-up efforts may not act as full substitutes for top-down approaches, subnational activities via local initiatives (as policy experiments) can help and find efficient abatement strategies by changing the *mind-set* of society, and thus (via social pressure) the business actors and most importantly high-end politics [Bernauer and Schaffer, 2010: 20].[87]

China: [88]

China has replaced the US in becoming the largest emitter. Today China holds a share of 22% of global annual emissions (see table 3), even though per capita emissions are considerably lower compared to OECD averages. China holds an unconditional pledge, which states that it would lower GHG emissions per unit of GDP by 40-45% relative to 2005 by 2020, increase non-fossil fuels (primary energy consumption) to $\sim$ 15% by 2020, extend forest area by 40 million hectares, and similarly stock forest volume up by 1.3 billion cubic meters relative to 2005 by 2020 [UNEP, 2012: 15].

Under the Kyoto rules, China's emissions, which are mainly driven by the export sector, are fully assigned to China because they have developed within its borders (responsibility is assigned to China on a production basis). Chinese emissions

[87]Consider also Lutsey and Sperling [2007], Selin and VanDeever [2007], and Tang et al. [2010]. Similarly, regional and international approaches define bottom-up and top-down forms, and a mixture between both is possible, where a regional regime would complement a global regime [e.g. Najam et al., 2006]. For gametheoretical arguments of bottom-up approaches consult Carraro [2007].

[88]If not mentioned otherwise, this paragraph is based on Pan et al. [2008].

would be much smaller (of up to 30%) if calculated via consumption accounting [Pan et al., 2008: 371]. Developing exporters (e.g. China) observe a rapid increase of GHGs relative to rich OECD states. They feel wronged because the rich (OECD) consumers accuse them of not taking climate change as seriously as it should be taken, even though the OECD represents the market which developing exporters are supplying and has been responsible for the biggest share of global cumulative emissions so far [Pan et al., 2008: 355]. Taxing *grey* emissions, i.e. emissions consumed elsewhere compared to where they are produced, is very difficult since such a taxation would clash with the rules of the WTO as well as the competitive production advantages. Attributable emissions thus remain an issue of conflict when it comes to climate negotiations with China, and they could be solved only if a post-Kyoto framework obliged the North to come up for at least a portion of the current emissions from developing exporters.[89] Helm [2008: 220] similarly states that consumption matters greatly, and not only the geography of production. Attributable emissions do have a further effect on the credibility of CDM projects. If the North cannot be made responsible for grey emissions, then there is a great credibility issue if it wants to implement CDM projects in China while its other products are simultaneously produced in dirty environments. In addition, other abatement efforts like domestic reductions lose credibility if the North is not ready to own up to grey emissions [Pan et al., 2008: 356/370]. Further it is argued that while China has attracted production to its own territory, the North has pushed dirty production abroad while installing stricter climate policies to meet its Kyoto targets. But as Hepburn and Stern [2008: 267] perfectly note, if the whole world was subject to a CAT-system, then it would not matter whether caps were calculated on a production or a consumption basis, but on the primary allocation. Somehow or other, the North is going to emit more than the South, and it will always pay the South to purchase certificates. What is recommended is a more comprehensive outlook on allocating responsibility and thus an alternative accounting approach; otherwise China will probably not commit to any binding emission reductions.[90]

India: [91]

India's position w.r.t. climate has been dismissive so far, as has that of many

[89] Chinese officials raised this point at the 2007 Bali negotiations [ENB, 2007].
[90] For the allocation of attributable emissions consider Grubb [1995: 494].
[91] If not mentioned otherwise, this paragraph is based on Joshi and Patel [2009].

developing states. India's government has in this regard announced only that it should not allow domestic per capita emissions to be higher than those in developed states. India (like Africa) stands at a higher risk to be hit by climate change than geographically better located countries like the US, China, or Russia [Joshi and Patel, 2009: 169]. Why India should participate in a climate treaty has several reasons. One is obviously the higher vulnerability towards climate change. Another reason is that besides China or the US, India is the most important key player [Joshi and Patel, 2009: 191-193]. Neither will join if the other will not.[92] India would welcome a CAT more than a CT because of equitable burden sharing [Joshi and Patel, 2009: 172], and it holds an unconditional pledge that emission intensitiy of GDP should by dropped by 20-25% relative to 2005 by 2020 [UNEP, 2012: 15].

Africa: [93]

Africa is important for the international environmental negotiations for two reasons. First, it is affected by ET, and thus designs opportunities for Africa. Second, the huge land-use-changes contribute to $\sim$ 20% of global emission changes [Williams et al., 2007]. The CDM is meant to operate in Africa as well. However, Africa barely engages in this scheme, with only 2% of all traded CDM-investments going to Africa [Collier et al., 2008: 350]. The CDM is usually absent in low-GDP African states since credible CDM proposals can hardly be achieved there. The CDM requires much documentation, baseline construction, and financial arrangements. These represent similar issues which appear in direct foreign investments. The investment *climate* is not very attractive in Africa and this contributes to a failing of the CDM.

Also, deforestation is left outside the CDM framework. The EU-ETS does not accept afforestation/reforestation projects at the moment [Collier et al., 2008: 350]. Forestry credits are not going to be included earlier than 2020.[94] This is highly critical since the LULUCF is responsible for 20% of total emissions [Pereira and Jourdain, 2012: 155]. The reason for Brazil's rather high carbon footprint is deforestation. Even Stern et al. [2006: 25] note that curbing deforestation is a very cost-effective abatement strategy. Hepburn and Stern [2008: 277] further state that a treaty on deforestation should be set up as soon as possible, since capturing

[92] See coalition-building problems in section 5.

[93] If not mentioned otherwise, this paragraph is based on Collier et al. [2008].

[94] See $< http://europa.eu/rapid/press-release\_MEMO-08-632\_en.htm >$.

Table 3: Distribution of emissions

actor	*emissions p.y.*	$\frac{emissions\ p.y.}{capita}$	*share*	$\frac{GDP}{capita}$	*population*(*10^6)
EU (27)	4'999	9.9	10%	32.83	503.70
USA	6'715	21.39	13%	41.11	313.91
China	11'182	8.32	22%	5.45	1'344.13
India	2'692	2.17	5.4%	1.51	1'241.49
South Africa	422	8.3	0.84%	8.07	50.59

details: *emissions p.y.* refer to the annual emissions in $MtCO_2$-equivalent; $\frac{emissions\ p.y.}{capita}$ is the former divided by the current population size; *share* notes the share of individual emissions w.r.t. global emissions (in %); $\frac{GDP}{capita}$ is given in USD and adjusted for PPP (purchasing power parity). The calculation accrues from the Emission Gap Report for 2012 [UNEP 2012: 15-16]. Since only numbers for *emissions p. y.* and the *share* are given (for 2010), the yearly emissions per capita are derived by using the latest population statistics (see *population* in millions) via < *http : //www.worldbank.org* >, and for the the *EU*(27) via < *http : //epp.eurostat.ec.europa.eu/statistics_explained/index.php/Population_and_population_change_statistics* >. $\frac{GDP}{capita}$ is further derived via < *http : //www.worldbank.org* > and the EU number via < *http : //epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/* >, which is converted into USD. In addition, it it worth noting that Canada and Australia both show similar numbers for $\frac{emissions\ p.y.}{capita}$ like the US, and Japan shows a similar number like the EU(27) < *http : //data.worldbank.org/indicator/EN.ATM.CO2E.PC* >.

large-scale carbon sequestration will get more expensive with time passing. Solutions to encourage Africa to climate change could happen in two ways. The first involves capacity development to participate in CDMs as presently are constituted, and the second means to enlarge the CDM's potential project range (include the power sector, waste disposal, and deforestation). Climate change is not attributed to being created in Africa, but because of the continent's geography, agricultural dependence, as well as adaption problems, Africa is likely to be hit hard by climate change [IPCC, 2007b]. Thus, not only Africa's governments have to act, but foremost the global community has to make an effort to account for Africa. However, the African case is an unusually malign one since the continent has no institutions, and well-functioning governments are not going to be set up any time soon.

Table 3 gives the distribution of CO_2 emissions (and GDP) for every country or union discussed above.[95] The story of the former four climate positions goes

[95] South Africa is listed only as data for Africa in the UNEP [2012] is not given. Thus, South Africa does not represent the continent Africa since GDP and total emissions would be considerably lower for the African average.

something like this [Victor, 2006: 91]: The country having the largest carbon footprint, the US (see table 3), is not a member of the Kyoto treaty. The EU (27), having the second largest carbon impact (see table 3), is the most ambitious member of the KP but its stand-alone position has barely affected the path of CO_2 emissions and the European economic crisis does not help, either. The factory of the world, China, is a Kyoto member but faces no reduction targets and its emission trend is rising [Rogeberg et al., 2010]. The fourth member is India, which has vehemently opposed any emission limits, and which exhibits an acceleratingly growing population.[96] One should keep in mind that the goal is to decrease or at least stabilise the atmospheric carbon stock, and Stern et al. [2006] write in this regard:

> "Stabilising at $\leq$ 550 ppm $C0_2e$ (= equivalent) would require global emissions to peak in the next 10-20 years, and then fall at a rate of at least 1-3% per year. By 2050, global emissions would need to be around 25% below current levels. These cuts will have to be made in the context of a world economy in 2050 that may be 3 - 4 times larger than today - so emissions per unit of GDP would need to be just $\frac{1}{4}$ of current levels by 2050."

But *no* country has adopted a *binding* policy so far to meet such suggestions. At this point it seems important to address some numbers on total world population, which reached $\sim$ 7 billion in 2011 and is expected to reach $\sim$ 9 billion by 2045.[97] India, China and the continent Africa already each currently depict a population of $>$ 1 billion and it is estimated that they will each display a size of 2 billion by 2050 [Helm, 2008: 214]. But population numbers are not the only *adverse* trends; energy demand and transport suggest similar (pessimistic) patterns. According to the IEA [2011: 3-4] global energy demand will rise by $\frac{1}{3}$ by 2035, and China will tighten its position of being the biggest energy consumer. Moreover, energy demand as well as CO_2 emissions rise even more than population [Helm, 2008: 214] (e.g. primary energy consumption rises with an accelerating speed [IEA, 2011: 3]). Success of promising negotiations looks bad since a secure energy supply ranks above climate protection, and many countries such as China, the US, and Canada are opening up new gas sites or oil and coal reserves [IEA, 2012].

[96] India has the largest population growth rate and its population will soon overtake the Chinese one (see table 3). ~50% of its population are under 25 years old $< https : //www.cia.gov/library/publications/the - world - factbook/geos/in.html >$.

[97] See $< http : //www.worldometers.info/world - population/ >$.

3.2 Climate coalitions

Due to the global character of environmental issues there infer interdependencies among individual countries and strategic behaviour. Since Rio new coalitions have sprung up and existing ones extended or fragmented.[98] The formation of state-coalitions depends much on group dynamics and network play, but also on development of leadership and the institutional background behind negotiating tables [Chasek, 2001: 25]. Most positions are negotiation-specific, issue-specific, and geo-politically motivated. A general categorisation can, nonetheless, be made (see table 4).

Talks are usually about the South blaming the North for historical emissions, and thus the South's unwillingness to act until they reach the same level of economic development as the North [Andresen and Boasson, 2012: 63-66]. However, sometimes there is a crossing of those North-South boundaries (differentiation of EU vs. JUSSCANNZ as the Copenhagen conference clearly proved).[99] Four major coalition formations exist under the Sustainable Development Commission (CSD). Those include the EU *(i)*, the JUSSCANNZ *(ii)*, the Group of 77 together with China *(iii)*, and some countries with economies in transition *(iv)* [Wagner et al., 2012: 87]. Those groups dominate the negotiation tables also under the climate change regime, but are slightly more fragmented, and it is worth discussing the CSD-major ones in a first step before moving to the climate coalitions in specific. The EU *(i)* contains all 27 member states and thus also includes some former Soviet states. In contrast to many individual positions from other coalitions, the EU tends to have one overall position. The EU has included also Eastern European economies (see *(iv)*), and strict climate policy development grants credibility towards this coalition. Besides the EU, a coalition, also approached via a majority vote, emerged: the JUSSCANNZ *(ii)*. This formation includes all major, developed, non-EU players, which are Japan, the United States, Switzerland, Canada, Australia, Norway, and New Zealand. JUSSCANNZ meets regularly at caucases (however, attendance is relatively fluid) to discuss strategies for the main negotiations [Wagner et al., 2012: 86-87]. In contrast to *(i)*, each coalition member talks individually. The Group of 77 with China *(iii)* is the largest coalition and contains LDCs, SIDSs (small island states), OPEC-coutries (Organisation of the Petroleum Exporting Countries), and the major developing states. These are just

[98]For an overview of coalition dynamics and positions consult Wagner et al. [2012].

[99]The EU considered Copenhagen a *disaster* whilst Barack Obama called it a real success [Bäckstrand, 2011: 669].

Table 4: Party groupings

CSD	*Climate (UNFCCC)*
EU	*EU*
JUSSCANNZ	*EID:* Mexico, Korea, Switzerland *Umbrella Group:* Australia, Canada, Iceland, Japan, NZ, Norway, Russia Ukraine, US
Group of 77 & China	*AOSIS* *BASIC:* Brazil, South Africa, India, China *ALBA:* Bolivia, Venezuela, Ecuador, Nicaragua, Cuba *Mountain Coalition* *Arab Group* *LDCs* *African Group*
Central & Eastern Europe	

details: CSD = Commission on Sustainable Development; EID: Environmental Integrity Group; AOSIS = alliance of small island states; ALBA = Bolivarian alliance for the peoples of our America. The depiction of the illustrated groups is based on Wagner et al. [2012: 103]. Not all countries are listed since there is large fluidity inside and outside coalitions. There are many more coalitions (and new ones on the rise) such as the Group of Landlocked Developing Countries, the Carribean Group, etc., which are able to speak besides the big existing coalitions (listed above) [ENB, 2010b: 2]. Non-UNFCCC (informal) groups (such as the Cartagena Dialogue or the Major Economies) are not investigated at this point. Further, coalitions on biodiversity and forests such as Amazon states (e.g. Brazil), but also states on the other part of the world like Indonesia, would be important; the latter especially for the aspect REDD+ in climate change.

about all countries in Africa, Asia, and South America, and *(iii)* thus includes members from oil-producing states in the Orient up to the least-developed states. The last coalition under the CSD is *(iv)* including Russia amongst others. In comparison with *(i)* - *(iii)* this one has rather few account. Under the UNFCCC party groupings are more fragmented (see table 4). For *(iii)* this means that there obviously must exist multiple sub-groupings, which results in the largest degree of fluidity, since strandpoints other than economically driven ones are usually diverse.[100] This is because degrees of development within G-77 are different, and also because these states do not have the same resource interests. The Arab Group has other interests w.r.t. oil and climate mitigation than Tuwalu (represented by the AOSIS) or similarly vulnerable and poor LCDs.[101] Especially ALBA, short for *Alianza Bolivariana para los Pueblos de Nuestra America*, which represents countries with forests (acting as important carbon sinks), and the LDCs are interested in REDD+ and thus seek compensation for forestry projects [Wagner et al., 2012: 98]. Why G-77 sticks together is because all subgroups within agree on economic issues such as receiving funds, which should ideally be a fixed percentage of the Northern GDP per capita ratio from Annex I countries [Wagner et al., 2012: 112].[102] In addition, just before the Copenhagen negotiations, in November 2009, Brazil, South Africa, India, and China formed a group (known as BASIC), since all four represent emerging economies and therefore have started to share same interests w.r.t. funding, historical emissions, and adaption. A group which emerged from JUSSCANNZ (*ii*) is the Umbrella Group and is a loose coalition of

[100]See < *http://unfccc.int/parties_and_observers/parties/negotiating_groups/items/*2714.*php* >. They have not all presented a common mindset during Copenhagen (recall section 2.1).

[101]See Dessler and Parson [2006: 130-131] and < *http://blogs.ethz.ch/klimablog/*2012/12/12/*gehort − und − gesehen − am − un − klimagipfel/* >. This also militates in favour of a differentiation within the South (i.e. major emerging states vs. poor developing states [Pereira and Jourdain, 2012: 155]), and not merely between the North and South, since emerging China or Brazil are better off to tackle climate change than extremely poor countries or islands, since they are the ones which are least responsible, most vulnerable, and show the weakest capacity [Christoff and EcKersley, 2011: 439]. The same argument goes with OPEC-countries inside G-77 because Qatar, e.g., showed the incredible number of 44 metric tons of CO_2 per capita (for 2009) - which is more than the double amount compared to the US ratio (recall table 3) < *http://data.worldbank.org/indicator/EN.ATM.CO2E.PC* > and < *http://www.opec.org/opec_web/en/about_us/*168.*htm* >. Thus, some OPEC-countries even exhibit a (much) higher carbon footprint than some Annex I states. This suggests that not all states inside G-77 would have the right to call on assistance for mitigation or adaptation.

[102]OPEC-countries within G−77 should (induced by footnote 101) not have the right to enjoy financial help from Annex I states only because justice should be done because of historical debts from the North. The same logic applies to economies in transition of *(iv)*, which are not entitled to some funds and are much poorer than OPEC-countries [Wagner et al., 2012: 89].

non-EU developed states.[103] The differences between the EU and the Umbrella Group can be attributed to the fact that many climate leaders (except the UK) have social democracies with a corporatist interest-group interposition [Christoff and Eckersley, 2011: 443; Paterson, 2009]. The most prospective coalitions are the EU and G-77 with China. The JUSSCANNZ is not prospective at all since Japan, Canada, and NZ pulled out of Kyoto.

4 Control instruments and appropriate functions

4.1 Controlling mechanisms

The economics of climate change have much to do with the analysis of the trade-off of opportunity costs, i.e. costs of not producing emission-driven goods but benefits of having less environmental degradation, and benefits, i.e. producing emission-driven goods but having more environmental degradation, which can be more severe for some countries than for others. Aspects which economists[104] have to address or find out in future, cover w.r.t. order:

I the investigation of mitigation incentives for every agent (households, firms, and governments)

II the analysis of the mitigation efficiency level (i.e. minimising abatement costs, and finding matching policies and efficient technologies)

III the use of those mechanisms, which are best under any particular situation

I as a research field is well approached by game theory and addressed in section 5.[105] II and III have much to do with the investigation of marginal costs via policy instruments and are discussed in the following. There are three types of control

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[103] See < *http://unfccc.int/parties_and_observers/parties/negotiating_groups/items/2714.php* >.

[104] The economic perspective is very different compared to the one of a natural scientist. Whilst chemists or ecologists say pollution should be zero, economists rather opt for an *optimal* pollution level, which in the context of (static) economics is defined as the equality point of marginal abatement cost and benefit: $MAC \stackrel{!}{=} MAB$. This corresponds to the equilibrium where net benefits/gains are maximal, representing a powerful notion [Perman et al., 2003], which comes from optimising utility being equivalent to benefits minus costs: $max_X U(X) = B(X) - C(X)$. A different approach could be the minimisation of damage costs and costs of abatement: $min_X D(X) + C(X)$ [Chander and Tulkens, 2001: 83]. For the latter one could assume that costs are ∞ if warming goes beyond 2° Celsius.

[105] In order to understand which global regime best addresses control over GHGs, game theory definitely is the most helpful tool < *http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=397* >.

mechanisms to control GHGs. Those are inclusive structures (A), command and control (C&C) tools (B), as well as economic instruments (C) [Perman et al., 2003].[106] (B) and (C) are regulation activities.

The first control mechanisms are inclusive structures (A). They are categorised into three branches: bargaining over emission levels (i), liability laws (ii), and societal responsibility (iii). (i) is linked to the concept of Coase [1961], where state regulation would not be needed for the internalisation of externalities since property rights would be well defined. In this sense the parties involved and the causer would voluntarily bargain for a settlement. However, looking at the negative externality of a rise in global temperature caused by emissions, an application of the Coasean theorem does not work. In reality there is no institution that assigns property rights. Further reasons are imperfect and asymmetric information between parties, transaction costs, and negotiating power. Harstad [2012: 80-81] in this sense argues that Coasean bargaining does not exist at all. (ii) is coupled to the idea that there is a legal responsibility for one's actions or omissions [Meltz, 2012: 12-16]. A hypothetical example is a monetary sanction given to a firm for polluting a river in the past. (ii) would assure that the environmental damage is *paid back* in the hope that it could deter other firms from similar behaviour in the future. Real world numbers from liability cases of climate change show that the US could be held legally liable for annual costs of up to \$ 5 billion, and Exxon Mobil for up to \$ 1.5 billion [Lewis, 2009: 4]. Sigman [2007: 1959] states that (ii) could raise the efficiency from other climate change policy instruments (such as (C)), even if it is only used as a threat. Finally, for (iii) it is believed that externalities could be internalised by a change in preferences, which in turn would happen via providing information and education (on why having a high carbon footprint is bad). But consumer and supplier preferences cannot be altered that easily. This is why (iii) constitutes probably the weakest form of inclusive structures since social pressure is not a method, and trying to put a *moral* into the heads of the people remains virtually impossible. No sociologist nor psychologist has yet found instruments to change environmental behaviour or norms. Further, governments usually do not have much ability or interest to inform and influence their subjects [Keohane and Victor, 2010: 9].

[106] If not mentioned otherwise, section 4.1 is entirely based on Perman et al. [2003: 202-246] and Faure [2012]. For national and international policy responses consider Dessler and Parson [2006: 116-117]. For a great overview see Stavins [2003].

The second form of control mechanisms builds the C&C (B). C&C-tools are divided into two components: technology (t) versus emission standards (e). They define prescriptive necessities which a technology has to have, and/or how a firm is allowed to perform w.r.t. the environment. In the real world (t) and (e) constitute the most widely used ways of *direct* environmental regulation. (t) is in force when the regulator obligates a company to implement environmentally clean techniques. For instance, the best available control technology, shortly BACT, is the environmental standard administered by the US Clean-Air-Act [Desslar and Parson, 2006: 111]. Under this act the Environmental Protection Agency has e.g. the authority to restrict ozone-depleting chemicals such as chlorofluorocarbons (CFCs).[107] (e) or performance standards obligate companies not to exceed their maximally allowed amount of pollution (in terms of emissions). Cancer-causing substance chemicals found in ground water are e.g. regulated by standards rather than by the imposition of a tax.[108] Why C&C might fail to work despite its very reliable way of regulating environmental issues is seen in two reasons (besides reasons such as different expectations of $MACs$ and $MPDs$ (see section 4.2)): First, firms are not homogeneous compared to each other, which leads to different costs if trying to meet a standard. For example, if *firm 1* has bigger $MACs$ than *firm 2* (see figure 1), then it would be more efficient if the pollution allocation is set differently so that *firm 2* is allowed to emit more than *firm 1*. The result would be the saving of $MACs$ in the aggregate. Second, informational requirements are often insufficient, and the regulator is confronted with manipulated balance sheets. This illustrates asymmetric information where the *regulating* has less information than the *regulated* party [Hahn and Stavins, 1992]. Figure 1 depicts (e), the easiest environmental emission standard.[109]

The third form is (C) - economic instruments. There exist price and quantity instruments. The former consist of carbon taxes (CTs). Price instruments only consider *positive* taxes, and *negative* taxes (subsidies) are less important because, in the context of an over-provision of the public good *environment* [Hardin, 1968],

[107] See < *http://www.epa.gov/air/caa/title6.html* >.

[108] See < *http://water.epa.gov/drink/contaminants/index.cfm* >. This is because marginal pollution damage is much bigger than marginal abatement cost ($MPD >> MAC$) (see section 4.2); or in the context of public health economics that the costs of getting cancer is so high (steep MPD) that it is better not to allow cancerogenic substances at all.

[109] Figures 1, 2, and 3 are derived with the help of < *http://vwl.ethz.ch/down/simula/flash/Eng/Taxes.html* >.

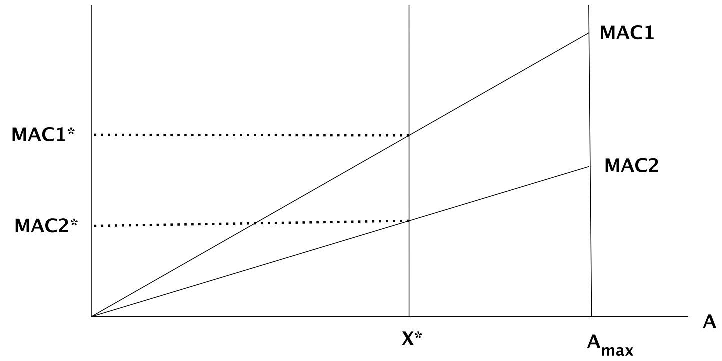

Figure 1: Emission standard

The x-axis represents abated emissions A, with A_{max} as the maximally abated emissions (which in the 1^{st}-best-scenario would be total mitigation). X^* is the emission standard set vertically for both firms *1* and *2*. The $MACs$ are given as linear approximations (the intercept thus does not necessarily have to be zero), where *1* has steeper $MACs$ than *2*. In equilibrium, the firm's optimal $MACs$ settle at X^*.

one wants to internalise negative externalities (the external cost is the amount of pollution representing it to be a public *bad* rather than a *good*).[110] The latter involves a market for tradeable pollution permits, which is referred to cap-and-trade (CAT) or the emission trading (ET). Predominantly, economic instruments are more favoured in comparison with direct regulation ((B)) because of behavioural change incentives. It is believed that firm and consumer behaviour could only be changed via clear market incentives, which, in turn, could lead to green innovation or adaption [Fischer et al., 2003; Requate and Unold, 2003]. Putting a price on a good, in this case on a *public* good, is the (economic) solution.[111] (C) are both shaped by economics, obviously, *and* politics, and surprisingly by a much wider degree [Helm and Hepburn, 2009: 4].[112] The CAT has been embraced more than CTs, and this has been politically driven.[113] However, the CAT is intended to be shaped to be as *price-like* as possible [Hepburn, 2009]. The benefits of (C) are of various nature [Aldy et al., 2003].[114] Cost-effectiveness is surely met, and

[110] Note in this context that *mitigation* is a public good whilst *adaption* is a private good [Bernauer and Schaffer, 2010: 8]. In this sense investing into adaption would "pay off" more.

[111] For (B) the pricing is done *implicitely* via standards.

[112] But the initial enthusiasm for (C) has gradually been dampened by politics (see section 3.1).

[113] See footnote 76.

[114] Before introducing a climate policy a government always weighs up factors such as cost effectiveness (whether the instrument is able to reach the reduction target at minimized costs), dynamic efficiency (whether the instrument is able to sustain CO_2 reducing incentives over time), additional advantages (whether an extraction of double dividends is possible), equity (whether wealth, or income, is equally distributed), credibility (whether a country can rely

the amount of information does not have to be very high.

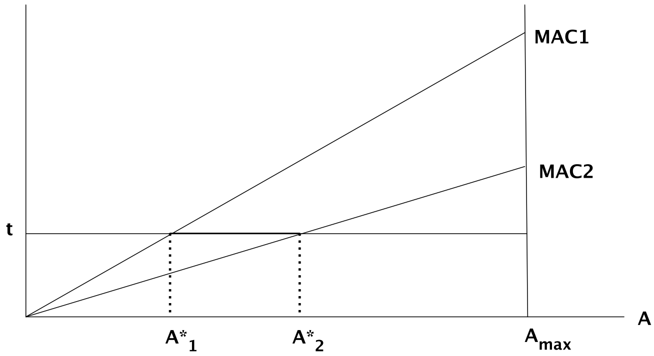

Figure 2: Carbon tax

The individual firm (or country) i faces the optimisation problem of $\min_{e_i} c_i(e_i) + te_i$, where e_i are the individual emissions, t is the tax, and $c_i(e_i)$ the individual costs of emissions. Setting the first order condition equal to zero and rearranging one gets $-c_i'(e_i) \stackrel{!}{=} t$. Since one unit of emitting is the same as the negative of one unit of mitigating CO_2 (i.e. $-c_i'(e_i) = -(-MAC_i)$), it holds that $MAC_i \stackrel{!}{=} t$ for i $\in$ 1, 2 [e.g. Finus, 2000: 36; Golombek et al., 2001: 121].

Under an emission tax (see figure 2), *firm 2* has lower MAC and thus will abate more ($A_2^* > A_1^*$). The tax t is set equally across firms, and *firm 1* will pay $(A_{max} - A_1^*)t$, and *2* will pay $(A_{max} - A_2^*)t$ for their (units of) emissions. Whilst the actual emissions in the aggregate can stay the same as under an emission standard (e), the tax solution is able to get this reduction with less costs (see figure 1 and 2), i.e. $\int_0^{A_1^*} MAC_1\ dA + \int_0^{A_2^*} MAC_2\ dA = TAC_1^* + TAC_2^*\ for\ CT\ < \int_0^{X^*} MAC_1\ dA + \int_0^{X^*} MAC_2\ dA = TAC_1^* + TAC_2^*\ for\ (e)$, where TAC denotes total abatement costs. Consequently, taxes are more efficient. In general, the idea behind CTs is to generate opportunity costs (i.e. taxes avoided). In the case of too high opportunity costs the company will rather abate than pay the taxes. Also, the tax should directly be placed on emissions, and should not be placed on products such as mineral oil or fuel. If the tax is levied at the socially optimal level, it is able to internalise the pollution externality completely; then it would not need any further regulation such as C&C, either. Looking at the real world and plotting the tax rate (on the y-axis) against the size of companies (x-axis), one observes a rather step-like declining relationship. Almost every EU country

on the instrument to meet a specific target), resilience (whether the instrument can easily be adapted to a new situation), uncertain costs (if the decision maker (DM) has been faced with wrong information about abatement costs, the security that dead-weight-losses do not explode), and the amount of information (how much information the DM should have until the instrument works) [Aldy et al., 2003].

has such an energy tax scheme, representing a game without frontiers [Speck, 2008]; thus for large emitters the tax is very small, otherwise they would suffer competitive disadvantages. The competition game between countries connotes that big firms could threaten to leave the country in case the tax was too high for them; something small firms, farmers or citizens and regular households could not do. With Australia introducing a carbon tax in mid 2012, small businesses now significantly suffer from high carbon taxes, even though their incentive to implement clean technologies should be increased implied by the tax.[115]

In contrast to the CT where the price is fixed, the CAT fixes the amount of maximally allowed emissions, or abated emissions respectively (see figure 3). Some find control over pollution quantity, and thus no uncertainty and perfect information about how many emissions there are in the system, a better way to address the exponential rise of total yearly emissions and thus of the atmospheric carbon stock.[116] The target of emissions in the whole economy with 2 firms is the same as under (e), equal to $2(A_{max} - X^*)$. With ET, the price of the certificate $p(E)$ should, at least in theory, be endogenously determined by X^*, which depends on ex-ante defined aggregate emission E, and all $MACs$.[117] The allocation and potential of costs are different to each other under a CAT. Overall costs for firm $i \in \{1, 2\}$ include not only its abatement costs $\int_0^{A_i^*} MAC_i \, dA$ but also the amount $P((A_{max} - A_i^*) - (A_{max} - X^*))$ in terms of emissions. The latter amount has only to be paid if $A_i^* < X^*$ (here for *firm 1*), and is equivalent to $P(X^* - A_i^*)$ in terms of avoided emissions A, which represents the payment in order to get the other firm's emission certificates. In figure 3 the traded quantity is $(X^* - A_1^*)$. Despite lower $MACs$, *firm 2* has overall higher aggregate "costs" because their gains would be even bigger by selling their entire potential amount of permits (if $A_2^* - X^* > X^* - A_1^*$). This potential amount of unrealised gains for *2* is indicated

[115] See < $http://www.news.com.au/business/your-business/carbon-pain-registers-for-businesses/story-fn9evb64-1226453653623$ >. Small players are, in general, worse off since they cannot finance lobbying and thus have lower *power*. Increasing burden of small players and decreasing burden of big players could, in this sense, eliminate *power* advantages of opposing (C).

[116] See < $http://www.esrl.noaa.gov/gmd/ccgg/trends/$ >.

[117] $p(E)$ will actually just settle at the level where it equals the shadow price of emitting one unit of pollution. Thus, each source will sell or buy permits until their MACs equal $p(E)$ [Montgomery, 1972]. Such conditions, similar to the CT and (e), obviously only hold if markets are perfectly competitive.

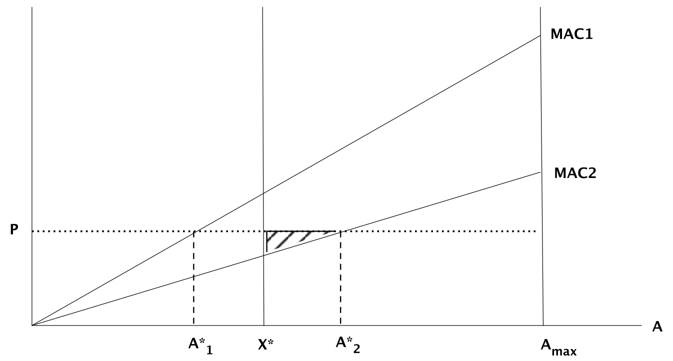

Figure 3: Tradeable permit

In contrast to figure 2, i here is confronted with $\min_{e_i} c_i(e_i) + p(E)(e_i - a_i)$ $s.t. \sum_{i=1}^{N} e_i = \sum_{i=1}^{N} a_i = E$, where a_i are the individual's allocated emission permits and $p(E)$ the endogenously derived certificate unit price of aggregate emissions E. Also, E $\forall$ N players has to equal the sum of single allocations of certificates a_i. The optimum involves $-c_i'(e_i) \stackrel{!}{=} p(E)$ [e.g. Finus, 2000: 36]. Again it holds that $-c_i'(e_i) = -(-MAC_i)$. If $t = p(E)$, then for the company it does not matter which policy instrument the regulator implements (compared with figure 2).

by the dashed triangle, $P(A_2^* - X^*) - \int_{X^*}^{A_2^*} MAC_2 \, dA$, in figure 3. For instance, Russia could not sell all their certificates during the CP I nor could it take over their excess permits to the CP II,[118] and "(...) the prospect of sending large quantity checks to Russia may provoke substantial opposition to complying via [the CAT] route" [Dessler and Parson, 2006: 163]. Summarising CAT, a government can build *pollution rights* and thus a market for a public good. These rights let the permit holder emit one unit of emissions within a particular time interval, otherwise emitting CO_2 is not allowed. The trading process lets total abatement costs be minimised, where the permit holder is the actor with the highest value of pollution. It is the actor which finds abatement most expensive. The initial allocation of pollution permits can happen in two ways: Permits can either be grandfathered or sold in an auction. Nowadays, permits are usually given away for free [Dessler and Parson, 2006: 108-109]. In this case permits are favoured over taxes. An example of the CAT is the European Emission Trading Scheme (EU-ETS) for Annex B countries under the KP, which includes $\sim 40\%$ of European GHGs from various sectors from energy, mineral refining to steel, glass, cement, paper, and pulp, and where every participating country to the EU-ETS has composed a NAP (national allocation plan) of the count of permit attribution to domestic companies [Wurzel and Connelly, 2011].

[118] And this is probably why it did not continue with the KP, besides acting unpredictably (see section 2.1).

The ongoing political discussion concerns the question of whether a quantity (a comprehensive global CAT) or a price regulation (a harmonised CT) is better.[119] The advantages of taxes are that it might establish higher prices of carbon,[120] and thus could help in the process of decarbonisation, and that firms will calculate abatement costs carefully, which in turn could improve their R&D investment incentives.[121] If one compares CTs with ET, then demand of permits is subject to uncertain volatility, for instance through direct changes in energy demand in a recession or a boom, whilst the supply of permits is constant. This leads to changes in permit prices and in turn lowers R&D incentives. During the first phase (from 2000-2005) of the EU-ETS too many permits were available, which led to the permit price falling dramatically [Hepburn and Stern, 2008: 271-272]. The permit price is still very low at the moment. The price in January 2013 reached a new record low of $\sim$ 2.8 Euro.[122] A CT might also be a quicker and less expensive way than a CAT [Wittneben, 2009]. One should, though, keep in mind that a CT is only a good (i.e. *unfixed* emission) policy instrument provided that society does not move on a path of exponential annual emissions. Flexibility of quantity is problematic if facing increasing emissions. However, the quantity of permits in the EU-ETS is not really fixed yet. Moreover, a harmonised tax, which would be the same for all countries (as Nordhaus [2007b] suggests) is politically not enforceable because countries are sovereign. If the UN dictated a CT for some country, it would experience heavy opposition, not only by voters but also by lobby groups. The ET is more enforceable on the international level than national carbon taxes, and for a global externality such as climate change, *international* regulation is necessary. A crucial drawback of CTs is fiscal cushioning, where

[119]A compact summary about *carbon pricing* can be found in Hepburn and Stern [2008: 270-272], and in Helm and Hepburn [2009]. Regarding welfare or social efficiency, taxes and permits behave the same since a target in figure 2 or 3 happens either via the x- or the y-axis (for a CAP or a CT, respectively).

[120]However, in recent years the carbon price has been subject to great variance. Today it is $\sim$ 5.9 per ton of CO_2. And there have been further decreases of the carbon price lately [CEC, 2011: 2].

[121]However, this is questionable as some experts state there could be more in-house innovation under a quantity instrument. Fischer et al. [2003] note that the imitation parameter, i.e. whether some country can copy a green technique of another country rather costlessly, will affect the circumstance whether a CT or ET will have a larger innovation incentive. If the parameter is 100% then permit markets with auctioning is favoured. If the parameter is close to 0% then CTs perform better. However, Helm [2009: 232] states that, for the case of EU climate change policy, no technology is really affected by the carbon price, and innovation is just the outcome of direct market intervention through the government.

[122]See $< http : //www.guardian.co.uk/environment/2013/jan/24/eu - carbon - price - crash - record - low >$.

the government would have the incentive to lower other taxes (e.g. fuel) and pay coal-related subsidies, which would, indirectly, again lower and dilute the carbon price. To reduce such cheating, one could perhaps fix the lower cap of other taxes, or the upper cap of subsidies respectively. In this way a government could fulfill a climate treaty by cushioning, which in the case of ET is not possible since the *only* trouble with a quantity regime is to meet the cap. Nevertheless, cheating under a CAT can happen via falsification of emission reporting, but can usually be exposed more easily than tax cushioning (since tax systems are often complexly designed). There also exist hybrid schemes between CTs and ET [Dessler and Parson, 2006: 109]. One example is a tax which is only charged on emissions exceeding some baseline. Similarly, a CAT can have safety valve mechanisms to avoid large changes in permit prices. For instance, for a price ceiling this means that if the price limit is exceeded, then permits can be issued beyond the pre-established quantity of permits. However, this is not important since the permit price is very low anyway. To adjust the CAT a tax can be levied on emissions, if these go beyond some critical value (e.g. too many *domestic* emissions, which are financed with permits bought from others), or rebated if emissions decrease more quickly than expected (i.e. giving incentives to participate in ET via a CT). Holding back reserves of permits could also be an option. During the CP I there were many excess permits. Taking excess permits out and introducing them at a later stage could be more effective.[123]

The KP operates under three market-based mechanisms *(i)-(iii)*.[124] The ET *(i)*, or CAT, is nothing more than abatement through trade, e.g. figure 3. Whilst the ET as specified under the KP only includes Kyoto gases and involves trade among countries, the EU-ETS involves trade among firms. Joint implementation, or JI *(ii)*, allows an Annex B party to earn GHG reduction credits from green projects (reduction or carbon sink projects) in another Annex B country. JI is not considered as important as the CDM (or the Clean Development Mechanism *(iii)*), which deals with certified green projects in the South (non-Annex B), e.g. in China and India, where there exists huge emission reduction potential at low cost and thus rather flat marginal abatement costs, at least in some ranges of

[123]Again, if there is an oversupply of permits, the permit price drops (due to a decrease in demand), and thus R&D incentives are lowered, where $MACs$ remain the same. In figures 1-3 the slope of the $MACs$, in this sense, could be lowered with exogenous innovation and adaption increases.

[124]See < *http://unfccc.int/kyoto_protocol/mechanisms/items/1673.php* > and Pereira and Jourdain [2012: 150].

abatement at the beginning. Thus the CDM works as "picking the low hanging fruit, or the cheapest emission reductions" [Hepburn and Stern, 2008: 273]. On the contrary, Switzerland (i.e. the North or Annex B) has already abated considerably and thus finds itself in the abatement interval, where $MACs$ are rather steep. Under *(iii)* the Annex B party can earn credits (CERs or certified emission reduction credits), which it can use or sell on the CAT carbon market such as the EU-ETS by implementing such projects in developing states. The South does not have access to good and efficient technologies, and does not commit to climate change abatement. This thus makes *(iii)* a very attractive credit-based flexibility mechanism since two goals can be achieved: technology transfer and GHG reduction. The crucial aspect of the CDM is the additionality criterion of CERs, one has to make sure that GHG reduction would not have happened anyway, and thus militates in favour of a strict monitoring scheme. All three mechanisms *(i)-(iii)* should only act as a supplement to domestic climate change abatement.[125] The largest part of CO_2 reduction should happen inside Annex B states, as it should incentivise more inhouse green innovation, and lowering the quantity of allowed CERs would mean to raise such incentives. Developing new-market based mechanisms to promote mitigation under cost-effectiveness will stay a major goal from Doha onwards (see sections 2.2 and 3.1).

4.2 Appropriate functions

There are two dimensions used in game theory as well as environmental and resource economics.[126] A model can either be set up in terms of an emission [e.g. Finus and Rundshagen, 1998; Carraro and Sinisalco, 1993] or a GHG reduction dimension [e.g. Barrett, 1994]. The first considers damage and benefit functions of emissions, and the latter uses benefits and costs of abatement. In general, a GHG is best modelled as a stock pollutant. The damage function then represents the global damage of CO_2-equivalent emissions, which is the sum of the negative externalities, or the social costs of carbon, and attaches a value to it. It is dependent on the accumulated atmospheric stock (rather than the flow of emissions). This is due to the reason that what matters is not the singleton, or one unit, of emissions, but rather the accumulation of all emissions together.

[125] See $< http://www.bafu.admin.ch/emissionshandel/05556/index.html?lang=de >$.

[126] Differences between payoff structures used in coalition theory and e.g. dynamic pollution games with stock variables are worth examining. The different notes on different types of function representation are partly drawn from Perman et al. [2003].

However, damage is hard to quantify (see section 6.3) as it should account for the effects caused by global warming on future generations and thus needs the frame of an intergenerational approach [Weitzman, 2003]. A damage function $D_t = D_t(S_t)$ is dependent on the stock of carbon in the atmosphere S_t at a given time. This stands much in contrast to gametheoretical coalition building models, where the polluting variable (emissions) is specifically treated as a flow variable, and would therefore not accumulate in the atmospheric stock of carbon [Barrett, 1994]. Pollution dynamics, on the other hand, assume the accurate choice of stock dependence. Kellow and Boehmer-Christiansen [2010: xi] in this context note that because of the long-term residence time of $\mathrm{CO_2}$, the issue is one of *stocks*, but international policy treats it as one of *flows*. The damage function is best captured by a convexly rising function of pollution ($D_t'(S_t)$, $D_t''(S_t) > 0$), since only then it can account for *uncertain* climate damages and risk-aversion. A positive slope of marginal pollution damage (MPD) is thus assumed: the increment in damage if the atmospheric carbon stock rises (by one unit).[127] In contrast to damages, benefits depend on the flow of current emissions since they represent the current advantage from being permitted to emit CO_2 emissions (E_t) for production. The benefit is noted as $B_t = B_t(E_t)$ and could be modelled as concavely rising ($B_t'(E_t) > 0$ and $B_t''(E_t) < 0$), showing that with infinitely many emissions (in the limit) no marginal increase in benefit (for production) can be achieved, since the resulting environmental damage from emissions is infinitely high. Thus there exist negative marginal pollution benefits $MPBs$ (the slope of a concavely rising function falls with more E_t).[128]

The idea is to put damage and benefits into one (utility or payoff) function, and, if modelled non-dynamically, to be able to perform comparative statics (in environmental economics), or to explore Nash equilibria and similar concepts in game theory (see especially section 5.3). In this sense a transformation from E_t to S_t has to occur. Presented in a two-dimensional graph if the x-axis constituted the *pollution flow* (similarly as the *abatement flow* in figures 1, 2, 3), it would need to undertake a change to *pollution stock*. The MPD (of $\mathrm{CO_2}$(e) emissions) then gets flatter and shows a small positive slope. A flat slope thus indicates stock

[127] The static approach usually works with marginals, where *linear* approximations are used since they can easily be visualised in graphs (see the static marginal abatement costs $MACs$ in figures 1, 2, 3).

[128] $MPBs$ are the same as the marginal emission benefits $MEBs$ (since emission is equal to pollution). Note that the term *pollution* in this regard captures both - the flow of emissions E_t and the stock of carbon S_t.

dependence (rather than flow dependence) in the case of climate change. This is very different to the case of e.g. cancerogenic substances found in ground water, where MPD is very steep.[129] If one abated one unit more of CO_2(e), considerable damage reduction could not be achieved (one should abate many units to decrease the atmospheric carbon stock). For the case of cancerogenic substances in ground water, on the other hand, one would enjoy significant marginal abatement benefits ($MABs$) if one unit more of substances was abated (and thus argues for damage control, which is best addressed by an emission standard *(e)* (see section 4.1)).

If one assumes the x-axis to be abated emissions instead (as used in figures 1, 2, 3), one gets the exact mirror image of the marginal functions described above. The functions would then simply mirror along the y-axis. The first marginal is simple: the marginal cost of abatement (MAC) is positively linear since it comes from a convexly rising abatement cost function. In comparison with stratospheric ozone, the $MACs$ there are considerably lower than for climate change mitigation [Bernauer and Schaffer, 2010: 14]. The abatement cost function itself depends on implementing green technology and innovation, and abatement gets more expensive if a high level of abatement has already been achieved.[130] The other marginal originates from the damage function of pollution. It again represents the exact mirror image of the MPD (mirrored along the y-axis), and thus indicates a convexly falling damage function w.r.t. abatement. A higher benefit from abatement is thus a lower damage from pollution. In short, if in the linear marginal's graph the x-axis represents the quantity of abated emissions, one has positively sloped $MACs$, and negatively sloped marginal abatement benefits $MABs$, or negatively sloped $MPDs$ (the same as a double negative).[131]

Because of climate uncertainty [Pindyck, 2007] and imperfect information it is best to take expectations for the presented functions. Further, economic instruments *(C)* (in section 4.1) perform variably well if there are differences in slopes and intercepts (if considering linear functions). Nordhaus [2007b: 37, 2008] e.g. criticised quantity instruments under imperfect information of inter-

[129] See $< http://www.eoearth.org/article/Risk\_assessment\_of\_chemical\_substances >$.

[130] This is the case for the EU, where abatement has already been realised at relatively low costs. Since further increases in domestic GHG abatement are very expensive, reducing emissions in poor countries via the CDM seems the better strategy for the EU, where abatement can still happen at low costs (see section 4.1).

[131] Abatement is the contrary of pollution, and benefit (of production) is the contrary of damage. Note that the presented notions on appropriate functions are intended to show intuitions. It is not stated which variables should be defined exogenously or endogenously (similar to endogenous growth models in economics), or on how many variables a function depends, etc.

cepts and slopes. Because of flat climate $MABs$ and steep $MACs$ for the North the price should be fixed via a CT [Hoel and Karp, 2001; Pizer, 1999]. Thus the Kyoto quantity regime (the market-based ET scheme) could in this sense lead to great welfare losses or inefficiencies.[132]

Eventually, governments do not know the marginal benefits, marginal damages, etc. It is, for instance, contested whether marginal damages are linear (and if so, to which degree), or include tipping points and militate in favour of abrupt climate change [Lenton et al., 2008], i.e. describe level effects and thus discontinuities.[133]

5 Gametheoretical approach to coalition building

5.1 Overview of models

There are strong interactions between key climate actors (see section 3.1). Game theory in this sense tries to investigate the behaviour or response expectations in coalition models, and explain failure like free-riding incentives in the climate game [Barrett, 1997a: 239]. It thus also tries to explore mechanisms, which deter free-riding and incentivise higher coalition cooperation. According to Stoschek [2012: 5-15], an overview of coalition building models can be done by means of three crucial properties: identity of actors (i), time horizon (ii) and solution method (iii).[134]

Most models, because of simplicity, assume homogeneous, i.e. symmetric, players (SPs) [Barrett, 1994/2002; Bloch, 1997; Carraro and Sinisalco, 1993; Finus and Rundshagen, 2001; Finus, 2001/2003; Yi, 1997], but there exists also a wide variety of contributions with heterogeneous, i.e. asymmetric, actors (APs) [Barrett, 1997c; Botteon and Carraro, 1997/2001; Carraro, 2000; Chander and Tulkens,

[132] But again, Weitzman [1974] calculates differences in expectations for all possible uncertainty areas and concludes that cheating is more likely under CTs (since countries could offset the policy instrument and say that it would be due to high $MACs$), which argues for a CAT.

[133] Associated with discontinuous functions, where the slope for every jump onto another level would be maintained, would then be the question of how to make an approximation to get a continuous function, since just to infer a convexly rising function would not be enough, as the slope in this case would be different at every point on the curve.

[134] It is not differentiated w.r.t. simultaneous or sequential games since most games are modelled as simultaneous games [Finus, 2001: 222]. On the other hand, the assumption of sequential moves is considered in Barrett [1994, 1997c, 2006].

1997/2001; Eyckmans and Finus, 2006; Finus and Rundshagen, 1998/2003; Germain et al., 1995; Hoel, 1992] for (*i*). Models assuming APs are more complex and usually involve simulations instead of analytical solutions.[135]

(*ii*) regards either a static (SG), or, more complicately, a dynamic game (DG). Static games usually regard the global emission (abatement) game (see section 5.3) [Barrett, 1994/1997c; Bloch, 1997; Botteon and Carraro, 1997/2001; Carraro and Sinisalco, 1993; Carraro, 2000; Eyckmans and Finus, 2006; Finus and Rundshagen, 2001/2003; Finus, 2001/2003; Hoel, 1992; Yi, 1997].[136] Dynamic models imply that the static game is a one-shot picture of the dynamic game [Finus, 2001: 150].[137] Such repeated games are often referred to *super games* if they exhibit an *infinite* number of rounds played [Barrett, 1994/2002; Finus and Rundshagen, 1998].[138]

Which solution method (*iii*) is used is probably the biggest characterisation of a gametheoretical coalition model. There exist three methods so far: the non-cooperative approach (*a*),[139] the cooperative approach (*b*), and the new coalition theory (*c*) [Finus, 2003: 20]. For (*a*) it holds that every player wants to maximise its individual payoff (utility), and thus acts selfishly, as Carraro and Sinisalco [1993: 563] note. With a static time horizon (*a*)-models imply the analysis of conjectural variations (analysis of benefits when deviating from a coalition) [Finus, 2001: 220]. Also, if a SG is assumed, (*a*) implies the analysis whether a found solution is externally and internally stable, thus there can only exist one stable coalition at once [Finus, 2001: 219]. Most contributions assume (*a*) [Barrett, 1994/1997c/2002; Botteon and Carraro, 1997/2001; Carraro and Sinisalco, 1993; Carraro, 2000; Finus and Runshagen, 1998; Hoel, 1992]. For (*b*) not the individual but the aggregate coalition payoff wants to be maximised, and equi-

[135] Heterogeneity is especially important because not only the coalition size can be determined, but the question of *which* countries participate be answered (e.g. tables 7 and 8).

[136] The *2-stage-game* (via *(a)* in *(iii)*) (e.g. section 5.3) involves a first stage, which is referred to the coalition (or the membership) game (players decide non-cooperatively if they want to join a coalition). The second stage involves the emission game (coalition members act as one player and share the burden of abating emissions). If actors are assumed to be non-identical, then there can be a *third* stage [Stoschek, 2012: 6], in which profits and losses are distributed among coalition (non-fringe) members according to an allocation rule [Barrett, 1997c; Botteon and Carraro, 1997]. (The third stage is not the same as in the *3-stage-game* in section 5.3.) As Finus [2001: 220] regards every coalition member would get the same amount if actors were assumed to be homogeneous (i.e. SPs).

[137] That is true if the concept of conjectural variations is used (in the non-cooperative approach, i.e. (*iii*), *(a)*).

[138] Again this only holds if the model is (*a*) in (*iii*).

[139] (*a*) is also called the *decentralised* approach according to Calvo and Rubio [2012].

libria concepts involve the core characteristic analysing whether a given coalition is stable and lies in the core [Carraro and Sinisalco, 1998: 562; Tulkens, 1998: 36]. Thus *(b)* refers to the analysis of a *grand* coalition and thus implies the existence of binding contracts between the coalition members [Chander and Tulkens, 1997/2001; Germain et al., 1995]. Returning to (*ii*), if static, the first stage (the coalition stage) in the *2-stage-game*[140] is obviously skipped, and merely the stability of the coalition explored.[141] A rather new concept is (*c*), which is basically a mix between (*a*) and (*b*), where positive spillovers from coalition to non-coalition members and other coalition structures can be caused [Bloch, 1997; Yi, 1997].[142] (*c*) allows for multiple coalitions in contrast to (*a*) [Finus, 2001: 119], where only one possible stable coalition is allowed, and where fringe members usually behave as singletons (only one defector at a time). Thus, multiple coalitions could enable region-specific negotiations and agreements.[143] In general it holds that if assumptions get more complex, a solution is harder to find.[144]

5.2 The repeated prisoner's dilemma

The climate problem has often been stated to have the (symmetric) payoff structure of a prisoner's dilemma (PD) [Barrett, 2005; Finus, 2001: 22; Perrings, 2012: 61].[145] The gametheoretical formalisation links payoffs from the case if countries

[140] See footnote 136.

[141] In the real world a grand coalition tackling global warming does not yet exist, and thus *(b)* will not be discussed in the following. It might, however, exist after the establishment of a global contract in 2020 (see section 2.2). It might have been the case that for the problem around the ozone hole there existed something like a grand coalition (see section 6.3), but for the climate change dilemma exploring a grand coalition (and thus skipping the first stage of the global emissions game) seems too early; and a subgroup of the grand coalition always means inefficiency [Carraro and Sinisalco, 2001: 21].

[142] Consider also Eyckmans and Finus [2006] or Finus and Rundshagen [2001/2003].

[143] But for the climate problem there exists *one* political agreement so far (i.e. the KP), which allows only for *one* coalition. The same happens to be with the ozone problem with only one agreement (i.e. the MP). See also < *http* : //*www.ipcc.ch/ipccreports/tar/wg3/index.php?idp* = 397 >.

[144] For instance, if the model assumes APs instead of SPs, DGs instead of SGs, sequential instead of simultaneous moves, stochastic instead of deterministic models, discrete instead of continuous choice of variables (or vice versa), discrete instead of continuous time (or vice versa), then robust solutions sometimes do not exist. The question about the ideal model thus considers the trade-off between solvability and closeness to reality.

[145] The earliest contributions on public good problems were done by e.g. Hardin and Baden [1977], where the environmental game was framed as a PD. See also < *http* : //*www.ipcc.ch/ipccreports/tar/wg3/index.php?idp* = 397 >.

cooperate compared to the non-cooperative case if they do not.[146] In the 2-player case of the PD each player has two strategies, which are either "defect" (D) or "cooperate" (C). The PD is suitable to capture the malignity of climate change (see section 6.3) since all players are better off with cooperation, but each player has the incentive to free-ride, yielding the infavourable situation of non-cooperation. The alternative is to represent climate change in a framework of a (symmetric) chicken game [Finus, 2001: 25; Perrings, 2012: 61]. Both payoff structures (represented in the form of a normal game because of simultaneous moves) are given in tables 5 and 6. The dissension between both representation forms can be stated as follows: IEAs (international environmental agreements) occur in reality, thus it can be represented as the chicken game in table 6, but because cooperation size is either efficient nor complete, climate change is better represented by the PD (see table 5) [e.g. Barrett, 1997a: 252; Finus, 2001: 142]. The latter argument highly supports the non-cooperative PD structure.

The repetition of the static game in table 5 is approached in order to obtain an idea of a DG via the (a)-model in a symmetric 2-player-game (SPs), with an infinite time horizon and discrete time periods.[147] Capturing repetitive counters or stepwise adaptation means that emission reductions are permanently renegotiated (e.g. during the CP I and CP II, or the adaption of behavioural responses if a country drops out of an agreement (e.g. section 2.1)). Repeated games (where the same stage game is played infinitely or finitely many times), belong to the class of best understood dynamic games [Calvo and Rubio, 2012: 26]. As Finus [2001: 63] further notes, there are two possitibilities w.r.t. the time horizon of super games: either it is infinite or finite, but for the latter the termination point seems not to be sure (at which point in time negotiations end). Applied to reality, an infinite assumption is better since as long as climate change remains a problem

[146] Finus and Rundshagen [1998: 157] state that the damage function $D(E)$, which depends on aggregate emissions E, should be modelled as convexly rising, and the benefit function of individual emissions $B(e_i)$ as concavely rising ($\frac{\partial D(E)}{\partial E} > 0$, $\frac{\partial B(e_i)}{\partial e_i} > 0$, $\frac{\partial^2 D(E)}{\partial E^2} > 0$, $\frac{\partial^2 B(e_i)}{\partial {e_i}^2} < 0$) in order to get the proper representation of the climate change issue (see section 4.2). Similarly, Barrett [1994: 889-891, 2002: 534/537] states that if benefit and cost function (both captured by an individual payoff function $\pi_i(E, e_i)$ dependent on E and e_i) exhibit parameters, which represent the PD, then the model is said to have the PD-characteristic of free-riding incentives. Note at this point that Barrett [1994] sets up a model in terms of the abatement dimension, whilst Finus and Rundshagen [1998] use the emissions dimension.

[147] The following approach relies, to some extent, on Osborne [2004] and Stähler [1998], where punishments are assumed. For great examples of DGs with either SPs or APs consider Barrett [1994: 889-891] or Finus and Rundshagen [1998], who manage to solve their models mostly analytically, or Stoschek [2012: 72-98/109-117/154-156].

Table 5: Prisoner's dilemma

		j	
		C	D
	C	b, b	d, $\underline{a}$
i	D	$\underline{a}$, d	$\underline{c}$, $\underline{c}$

details: The payoffs are given as $a > b > c > d$, with i as the row player and j as the column player, where D constitutes the dominant strategy (i.e. always a best response (best repsonses w.r.t. a given strategy of the opponent are underlined) w.r.t. a given strategy of the opponent) for both players. The payoff (c, c) depicts the payoff for the unique pure NE (Nash equilbrium, i.e. two best responses to itself), which is lower than the socially optimal payoff (b, b). Preferences (e.g. for i) are given as follows: $\pi_i(C, D) > \pi_i(C, C) > \pi_i(D, D) > \pi_i(D, C)$ [Gibbons, 1992: 3]

to society and the planet, talks are not likely to finish. Also, it follows that it is not possible to sustain cooperation in the finite game since the subgame perfect equilibrium of a finitely played repeated (simultaneous) prisoner's dilemma will entail cheating (through backwards induction) [Dixit et al., 2009: 401] in every stage of the constituent game. This is because if there exists a unique NE in the normal form structure such as the PD, then for any finite time horizon, the repeated game exhibits one subgame perfect NE, which is the NE chosen in every stage [e.g. Gibbons, 1992]. At this point it is worth noting that the MP should be modelled as an infinitely repetitive game, whilst the KP is much better approached by a dynamic model with infinite repetitions (since Kyoto amendments or even the cancellation possibility at Doha 2012 are constant threats) [Stoschek, 2012: 171].

Consider two SPs where $i \in 1, 2$. Each player has a constant discount factor $\delta_i \equiv \delta \in (0, 1)$.[148] If the stage game in table 5 is played ∞ times,[149] then a grim trigger strategy means that once deviation occurs (e.g. in t_0), punishment from the victim's side will be forever/infinite: the victim would never forgive (starting

[148] The assumption of SPs can thus also mean that everyone values payoffs alike [Finus and Rundhagen, 1998].

[149] An infinite DG via (a) is the ∞-repetition of its corresponding SG per definition.

Table 6: Chicken game

i \ j	W	S
W	b, b	$\underline{c}$, $\underline{a}$
S	$\underline{a}$, $\underline{c}$	d, d

details: The payoffs are given as $a > b > c > d$, with i as the row player and j as the column player, where each player has two strategies "weak" (W) or "strong" (S) (i.e. "chicken" or "no chicken"). Best responses are, again, underlined. There are two Nash equilibria in pure strategies; (W, S) and (S, W), and since they are only met if i plays the other strategy compared to j, this game is also known as a coordination game (or similarly the anti-coordination game since coordination does not occur [Perrings, 2012: 61]). If both play tough, the worst outcome occurs (i.e. (d, d)), but, nonetheless, one prefers that the opponent is the chicken. If the static game is repeated the optimal solution is tacit coordination for both players [Dixit et al., 2009: 116-118].

one period later, e.g. in t_1) [Dixit et al., 2009: 401].[150] The average[151] discounted payoff for i from defection is (with rearrangements using the infinite sum of a geometric series)

$$\overline{\Pi_{i,D}} = (1-\delta)(a + (\sum_{z=1}^{\infty} \delta^z c)) = (1-\delta)(a + c\frac{\delta}{1-\delta}) = (1-\delta)a + c\delta \tag{1}$$

where $\overline{\Pi_{i,D}}$ consists of the current payoff of defection in t_0 (non-discounted $(\delta^0 c)$) and all discounted future payoffs from punishment c from t_1 onwards. The average discounted payoff for i from cooperation (with a payoff of b in every stage from t_0 until t_∞) is obviously exactly b or

$$\overline{\Pi_{i,C}} = (1-\delta)(\sum_{z=0}^{\infty} \delta^z b) = (1-\delta)b\frac{1}{1-\delta} = b \tag{2}$$

[150] The deviation phase happens as soon as some player lowers his emission abatement level compared to the cooperative individual abatement. The punishment phase follows the deviation phase and is characterised through a lower abatement in the aggregate (since coalition members punish the deviator through a lower abatement level, as well).

[151] This is indicated by the factor $(1-\delta)$ and represents a weighted average of every stage-payoff in ∞ periods [e.g. Barrett, 1999/2002].

Cooperation only happens if (1) $\leq$ (2)[152] or

$$(1-\delta)a + c\delta \leq b \Leftrightarrow \underbrace{\frac{a-b}{a-c}}_{<1 \ since \ a>b>c>d} \leq \delta \tag{3}$$

and thus if the discount rate is sufficiently high.

Now the case of *finite* punishment for p periods is considered (i.e. not a grim trigger until ∞), i.e. start with C and continue playing C unless the opponent deviates (if he plays D). Then punish him via deviating as well for p periods (independent of what the other one plays in those p periods). E.g. for the 2-player-case there is a deviator (let it be $i = d$) and a cooperator ($j = c$). Then at some point, say t_0, d will deviate. Then during $t_0 + 1, ..., t_0 + p$ (one period later after deviation and until the end of punishment) c will punish him (and deviate as well). d will play D in the p punishmnet periods, as well. The question is about why d should deviate in the first place. d's gain in payoff (from deviating at some point t_0) must arise from the payoffs during the periods t_0 and $t_0 + p$, or from the time interval $(t_0 + p) - t_0 = p$. The following payoffs are given for the case if the deviator deviates (4) or if he behaves well (5):

$$\pi_d = a + \sum_{z=1}^{p} \delta^z c = a + c \sum_{z=1}^{p} \delta^z = a + c\frac{\delta(1-\delta^p)}{1-\delta} \tag{4}$$

$$\pi_c = \sum_{z=0}^{p} \delta^z b = b + \sum_{z=1}^{p} \delta^z b = b(1 + \frac{\delta(1-\delta^p)}{1-\delta}) = b\frac{1-\delta^{1+p}}{1-\delta} \tag{5}$$

The first payoff (4) results from the fact that d gets a payoff of a in t_0 and payoff c for the rest of periods (during the phase of finite punishment lasting p periods). d also wants to see what happens if he plays nicely (does not deviate) (see (5)). Then during the (in this case *potential*) punishment periods d gets b each period. The potential deviator d will only play (5) if it is $\geq$ (4), which yields

$$\overbrace{\delta^{1+p}(\underbrace{c-b}_{<0}) + \delta(\underbrace{a-c}_{>>0})}^{>0} \ \geq \ \overbrace{a-b}^{>0} \tag{6}$$

Since inequation (6) cannot be solved easily w.r.t. δ, a different way is approached: by plugging in specific values for the parameters in the PD matrix, e.g. $a = 4, b = 3, c = 2, d = 1$, and letting p be varied according to p, $p+1$, $p+2$,

[152] The indifference case is included.

... (starting with $p = 2$ (since for $p = 1$ no solution for the endogenous variable can be found, $\delta \notin (0, 1)$)), one sees that with more p cooperation can only be sustained ($\pi_c - \pi_d > 0$) with a lower (critical) δ. Thus if one defined a function $\delta(p)$ then $\frac{\partial \delta}{\partial p}$ would be < 0.[153]

The presented examples are intended to show that discounting of future utilities (e.g. consumption) matters a great deal, and plays a major role in explaining free-riding behaviour. To which degree players value these future payoffs depends on the discount factor $\delta_i = \frac{1}{1+\rho_i}$, and makes them less patient if $\delta_i << 1$ or $\delta_i \sim 0$ (if the discount rate ρ_i is ~ 1). Barrett [2002: 534] states that the more patient a player is, the easier can cooperation, or a *stable* coalition (e.g. section 5.3 - 5.4), be sustained. If the discount factor is small, then people will not value future payoffs (of cooperation), but put more weight on decisions related to the short-term (where deviating seems the better strategy, e.g. investments into non-renewables rather than into renewables, or, similarly, investing into a conventional light bulb and not into a light-emitting diode (LED) bulb). Long-term benefits of climate abatement and cooperation are in this regard not visible to impatient players. Furthermore, possibilities of punishment are not really addressed in the KP so that compliance could be assured (see section 6.4).

5.3 Global emissions (abatement) games

The global emissions game if set up via the emissions dimension, or the global abatement game if set up via the abatement dimension, in the static approach usually consists of two stages [Botteon and Carraro, 2001: 39-40], where the first stage happens according to the *Nash-assumption* and players choose whether they want to join the fringe or coalition. In the second stage, after having set up the coalition, the actual game in terms of emissions (or abatement) is played. The second stage of the game can happen simultaneously [Botteon and Carraro, 1997/2001; Carraro and Sinisalco, 1993; Finus, 2001: 221], i.e. fringe and coalition members simultaneously choose their abatement levels (*Nash-Cournot*

[153] Another way would be by building the difference of (4) and (5), call it $\triangle(\delta, p) = (5) - (4)$, and let $\triangle$ be ≥ 0 to capture the incentive to play nicely (i.e. $\pi_c > \pi_d$), which obviously has to be associated with a high δ (recall (3)); by $\triangle(\delta, p) = \frac{b(1-\delta^{1+p})-a(1-\delta)-c\delta(1-\delta^{p})}{1-\delta}$ it is seen that $\frac{\partial \triangle}{\partial p} = \frac{\delta^{1+p}\ln(\delta)(c-d)}{1-\delta} < 0$ is negative (note that $ln(\delta) < 0$ since $\delta \in (0, 1)$). Thus if p rises (by one unit), the incentive to play nicely for a potential deviator d falls. The intuition (same as above) is that with more p, the less patient d becomes (δ falls since $\triangle$ falls (recall (3))). Thus if one defined a function $\delta(p)$, then $\triangle(\delta(p), p)$ would exhibit $\frac{\partial \delta}{\partial p} < 0$.

assumption). A characterisation of the global emissions game can be found in Folmer et al. [1998] and Finus [2000].[154] The emissions game is called a *global* game not only because it involves the effort of *all* countries but because the benefits of reducing emissions (the costs of not emitting) depend on the individual abatement level q_i of player i ($C_i(q_i)$), and the benefits of producing (environmental damages) depend on the *aggregate* abatement level $Q = \sum_{j=i}^{N} q_i$ of N players (i.e. $B_i(Q)$).[155] E.g. if *only* Switzerland or Croatia managed to cut their GHGs by some fraction, they would enjoy very little (local) advantages, such as green technologies or less air pollution, but their overall (net) utility would be ~ 0 or even < 0 [Bernauer and Schaffer, 2010: 12].

1-stage-game:

The most simple coalition game, written in the dimension of emissions, via (a) involves $N \geq 3$ actors $\in 1, ..., N$ negotiating for abating GHGs.[156] SPs are assumed, where each player i has the same strategy space and faces the same profit function.[157] The set-up thus exactly corresponds to the symmetric PD in table 5. As there exists no benevolent global dictator to solve the climate problem (which would be the 1^{st}-best-solution), the matter with all its players is a very complex one. Again this complies with table 5 where the complex matter means that, by the structure of the payoff matrix, the socially optimal outcome is not achieved in equilibrium. The strategy set of every i is given by {"abate", "pollute"}. The public good problem indicates that pollution is *socially* damaging, but abatement associated with *private* costs. Emissions are indicated by e_i, and can either be 1 or 0, and thus the choice constitutes a "all-or-nothing-choice" (discrete binary choice). The individual's payoff is $\pi_i(e_i) = e_i - \alpha E$, where aggregate emissions are resembled by $E = \sum_{i=1}^{N} e_i$ [Finus, 2000: 2]. The payoff function assumes a constant marginal damage (of aggregate emissions)

[154] A summary of IEA membership literature can be found in Long [2010: 52-53].

[155] This is especially observable in the example of the *3-stage-game* from Barrett [2006: 22] where the dimension of emission abatement is used, where $C_i(q_i) = \beta Q$, $B_i(Q) = \gamma \frac{q_i^2}{2}$, and $\pi_i = B_i(Q) - C_i(q_i)$.

[156] Section 6.1 suggests that at least *three* members are needed for *multi*lateral climate agreeements.

[157] It is important to assume SPs since only in this case the stability condition can be derived (for a proper analytical solution). However, not assuming heterogeneous actors (countries, firms) with e.g. different individual abatement costs or climate impacts sharply deviates from the real world, since one should at least differentiate between the North and the South.

indicated by $\alpha \in (0,\, 1)$.[158] The marginal benefit of emissions e_i is equal to 1, and thus constant, as well.[159] Player i faces two possible payoffs: either $\pi_i(1) = 1 - \alpha E$ or $\pi_i(0) = -\alpha E < \pi_i(1)$. The pure Nash equilibrium is thus $e_i = 1$ versus the socially optimal $e_i = 0$. Because SPs are assumed, everyone chooses the same strategy where $e_i \equiv \bar{e} = 1$ and therefore $E_{Nash} = \sum_{i=1}^{N} e_i = N\bar{e} = N$, compared to the 1^{st}-best-solution of aggregate emissions equal to zero (total mitigation).

2-stage-game:

In order to choose "abatement" a group formation (coalition) of $n \leq N$ members is possible from now on. From the original 1-stage-game one can come to a 2-stage-game where coalition membership is defined first (i.e. announcement game with coalition strategies {"in", "out"}). Afterwards, the original emissions game (see paragraph above) takes place. For the 2^{nd} game the coalition plays against the non-coalition-members (the fringe). The individual coalition-payoff with "abate" is $\pi_c(n) = -\alpha(0 * n + 1 * (N - n)) = -\alpha E_f$, where aggregate emissions only come from emissions of the $(N - n)$ fringe members (E_f). Thus, if $\pi_c(n) = -\alpha(N - n) \geq 1 - \alpha(1*n + 1*(N - n)) = 1 - \alpha N = 1 - \alpha E_{Nash} = \pi_f(n) = \pi_f \Leftrightarrow n \geqslant \frac{1}{\alpha}$, then coalition-members will choose "abate".[160] If $n < \frac{1}{\alpha}$, however, then they will behave like the fringe.[161] Because $\lim\limits_{\alpha \to 0} \frac{1}{\alpha} = \infty$ and $\lim\limits_{\alpha \to 1} \frac{1}{\alpha} = 1$ one gets $\frac{\partial n^*}{\partial \alpha} < 0$. Thus if marginal damage α rises, the critical number for the coalition size n (n^*) falls, which suggests a pessimistic result. Similarly, small numbers for n^* are found in literature, as well.[162] Furthermore, a n*-sized-coalition is (potentially) internally stable if $\pi_c(n^*) > \pi_f(n^* - 1)$. It is externally stable if $\pi_f(n^*) > \pi_c(n^* + 1)$. A coalition is stable if both inequations

[158] Linked to section 4.2 the MPD (i.e. α) is constant here rather than positively linear w.r.t. emissions (as section 4.2 suggests).

[159] Linked to 4.2, this would represent the MEB, which in the appropriate case would be negatively sloped.

[160] This is similar to a profitability condition [Finus, 2001: 222-223], which requires that every coalition member is better off with an IEA membership compared to a non-cooperative situation. Note in the case above that the indifference case is included, as well.

[161] It is clear that fringe-members will non-questionably always choose "pollute" since that is their ex-ante definition.

[162] Stoschek [2012: 197-202] gives an overview of many research papers, which usually result in $n^* \in \{1, 2, 3\}$. In the case above if $\alpha \in [\frac{1}{3}, 1)$, then $n^* = 3$ since n should be at least as large as some number in the interval $(1, 3]$ (where 3 is the maximum). In general, the equilibrium size of the coalition, n^*, depends on $\frac{1}{\alpha}$ and attributes the smallest possible integer for n^*. This smallest possible integer, call it $X(\frac{1}{\alpha})$, denotes the n^*. Thus introducing a 2-stage-game instead of 1-stage-game allows for a (weak) increase in overall abatement, even though the coalition size is very little.

hold.[163] Internal stability indicates that there is no coalition-member which would deviate to join the fringe (only "$n^* - 1$" coalition-members left). External stability indicates that there exists no fringe member which would deviate and join the coalition (new "$n^* + 1$" coalition members). Plugging in the values for internal stability one would obtain $-\alpha(N - n^*) > 1 - \alpha N \Leftrightarrow \alpha n^* > 1$, and for external stability one would obtain $1 - \alpha N > -\alpha(N - (n^* + 1)) \Leftrightarrow \ 1 > \alpha(n^* + 1)$. Thus the stability condition in this case for any n^* cannot be satisfied since $\alpha n^* > 1 > \alpha n^* + \alpha$ yields $n^* = \{\}$.

3-stage-game:

In the following a model is considered, which tries to capture the gametheoretical reason why Kyoto has failed so far [Barrett, 2006]. Barrett [2006: 22] for this reason assumes a more specific set-up of the above generalised static approach, and names it the *Kyoto approach.* The model is set up in the emissions reduction dimension instead of the emissions dimension (from before), where the variable abatement $q_i \in \mathbb{R}_0^+$ is treated as a continuous choice. The individual payoff is given by $\pi_i(q_i) = \beta Q - \gamma \frac{q_i^2}{2}$, where $Q = \sum_{i=1}^{N} q_i$, and the function is the same for every player (i.e. SPs). Here $\beta \in \mathbb{R}_+$ is the marginal benefit of total abated emissions Q. Since it is a one-shot game constant marginal benefits (i.e. linear benefits) are assumed.[164] This corresponds to the *constant* marginal damage α (from before). $\gamma \frac{q_i^2}{2}$, with marginal cost $\gamma \in \mathbb{R}_+$, indicates a quadratically rising cost function associated with abatement.[165] Setting $\frac{\partial \pi_i}{\partial q_i} \stackrel{!}{=} 0$ one gets $q_{i,Nash} =$

[163] Such conditions come from classical oligopoly theory of industrial economics [D'Aspremont, 1983], and many empirical models use the stability condition to analyse commitment to membership (e.g. tables 7 and 8). Applied to reality, internal stability is a major problem because some countries decided not to participate in the CP II (section 2.2, see also Dellink [2011]). At this point it is worth noting that if players play Nash in the global static 2-stage-game, they are automatically myopic since they do not assume that their behaviour (if they want to leave the coalition) could alter the stability of a coalition [Finus, 2001: 219]. Myopia is thus different than farsightedness [Hoel, 1992]. Implied by myopia is the fact that coalition players stick to their position, even though this does not necessarily lie in their own interest [Barrett, 1997a: 252].

[164] Because in section 4.2 the *MAB* (β) should be linear with a small negative slope (i.e. the slope is slightly negative since the x-axis is the abatement; it would be slightly positive if the x-axis was written in the emissions dimension), a constant β for climate change is again not appropriate.

[165] This corresponds to an appropriate cost function (see section 4.2). Also, by $\frac{\partial \pi_i(q_i)^2}{\partial q_i^2} = -\gamma$ and if $\frac{\beta}{\gamma} > q_i$ (i.e. $\frac{\partial \pi_i(q_i)}{\partial q_i} = \beta - \gamma q_i$ is < 0), the payoff function is a concavely rising function, which again corresponds to an appropriate function (see section 4.2), where with very much abatement there is almost no increase in a player's payoff since costs are very high with high

$\frac{\beta}{\gamma}$ (the Nash result).[166] On the other hand, if full cooperation was assumed, everyone would abate, yielding payoffs of $\pi_{i,c} = \beta N\overline{q}$ - $\gamma\frac{\overline{q}^2}{2}$ (where $q_j \equiv \overline{q}$ since all abate and thus have the same strategy). The first order condition for an equilibrium strategy in full cooperation yields $\overline{q}_c = \frac{\beta N}{\gamma}$ (the socially optimal result). Now modelling an IEA happens in three stages instead of the original two. At the 1^{st} stage each player chooses whether to become a signatory or not (participation in the KP is voluntary). At the 2^{nd} stage coalition members choose their level of abatement collectively, and then the fringe players choose their level independently at the third stage. The solution can be obtained via backwards induction,[167] where at the third stage the fringe plays $q_f = \frac{\beta}{\gamma}$ (the Nash result), and at the second stage the coalition, consisting of k members, plays $q_c = \frac{\beta k}{\gamma}$ (the socially optimal result, where N is substituted by k). Finally, at the first stage, it holds that k^*, the optimal number of signatories, should satisfy the internal and external condition via $\pi_c(k^*) \geq \pi_f(k^* - 1)$ and $\pi_f(k^*) \geq \pi_c(k^* + 1)$, where π_c is the total coalition payoff and π_f the payoff from the fringe (the same as before). The aggregate Q is thus equal to $k\frac{\beta k}{\gamma} + (N - k)\frac{\beta}{\gamma}$, and the individual payoffs are equal to $\pi_c(\frac{\beta k}{\gamma}) = \beta(\frac{k\beta k+N\beta-k\beta}{\gamma}) - \frac{\gamma}{2}(\frac{\beta k}{\gamma})^2 = \frac{\beta^2(k^2+2N-2k)}{2\gamma}$ and $\pi_f(\frac{\beta}{\gamma}) = \beta(\frac{k\beta k+N\beta-k\beta}{\gamma}) - \frac{\gamma}{2}(\frac{\beta}{\gamma})^2 = \frac{\beta^2(2k^2+2N-2k-1)}{2\gamma}$. Thus for internal stability to hold one would get $\frac{\beta^2(k^{*2}+2N-2k^*)}{2\gamma} \geq \frac{\beta^2(2(k^*-1)^2+2N-2(k^*-1)-1)}{2\gamma} \Leftrightarrow 4k^* - 3 \geq k^{*2}$, and for external stability one would get $\frac{\beta^2(2k^{*2}+2N-2k^*-1)}{2\gamma} \geq \frac{\beta^2((k^*+1)^2+2N-2(k^*+1))}{2\gamma} \Leftrightarrow k^{*2} \geq 2k^*$. By plugging in values for $k^* \in \{0, 1, 2, ...\}$, one sees that for the stability condition $4k^* - 3 \geq k^{*2} \geq 2k^*$ only $k^* \in \{2, 3\}$ is satisfied, which obviously yields by maximising coalition size $k^* = 3$. This again constitutes a very small critical coalition size. However, as Barrett [2006: 22] states, this does not even change with more countries ($\frac{\partial k^*}{\partial N} \approx 0$, or $\frac{\partial k^*}{\partial N} = 0$ since the stability condition does not entail N), and hence the specific model helps to capture the reason of failure of the KP. This leads to the conclusion that Kyoto is not self-enforcing [Barrett, 2005].

Table 7: Coalition analysis I

PANE	WI(%)	EI(%)	S
NASH	0	0	-
Annex B without USA	2	1	PIS
Annex B	8	3	PIS
USA + China	20	15	PIS
China + FSU + RoW	24	49	not PIS
USA + Japan + China + FSU + RoW	92	80	PIS
USA + EU + China + RoW	97	92	not PIS
PARETO	100	100	-

details: The following table accrues from Bréchet and Eyckmans [2012: 172], where the acronyms mean the following: PANE = Partial Agreement Nash Equilibrium, RoW = rest of world, FSU = former Soviet Union, Annex B = USA + EU + Japan + FSU, PIS = potentially internally stable, WI = welfare index, EI = environmental index, S = stability. PARETO is the grand coalition, whilst NASH is no coalition consisting only of fringe members as singletons.

5.4 Applied coalition formation and discussion of models

Bréchet and Eyckmans [2012] compute numerical simulations by using the CWS, the CLIMNEG world simulation, which is an integrated asssessment (climate - economy) model (IAM).[168] The model differentiates between six regions: USA, EU, former Soviet Union, China, Japan, and rest of the world (e.g. table 7).[169] In table 7 the PANE means that both the internal and external stability condition holds [Bréchet and Eyckmans, 2012: 166]. Moreover, a coalition is said to be PIS, if it ensures at least the free-rider payoff to its coalition members [Bréchet and Eyckmans, 2012: 167; Eyckmans and Finus, 2004]. Table 7 shows the aggregate welfare, which is captured by the WI ranging from 0-100%, and the environmental performance (dependent on the atmospheric carbon stock in the year 2200), which is characterised by the EI, again ranging from 0-100%. The non-cooperative

abatement ($\lim\limits_{q_i \to \infty} \frac{\partial \pi_i(q_i)}{\partial q_i} = 0$). Note at this point the links to section 4.2, where $MPD = \alpha$, $MAB = \beta$, $MAC = \gamma$.

[166] Note here that the derivative w.r.t. individual abatement q_i of $\pi_i(q_i) = \beta(q_1 + q_2 + ... + q_i + ... + q_N) - \gamma \frac{q_i^2}{2}$ is taken.

[167] Note here that Barrett [2006] assumes the *Stackelberg assumption*, since the originally second stage is divided into two stages, which happen *sequentially*.

[168] For an overview of IAMs consult Kolstad and Toman [2005]. Consider Bréchet and Eyckmans [2012: 168] for the CWS in specific.

[169] The US, EU, and Japan incorporate a high carbon footprint and a high GDP per capita (e.g. table 3), with high abatement costs (see section 4.2). China and the RoW in this regard show the exact contrary picture [Bréchet and Eyckmans, 2012: 173].

NASH as a "coalition formation" means no coalition at all, and depicts a world consisting of only free-riders, i.e. WI = EI = 0%. The socially optimal formation is indicated by PARETO, where everyone cooperates and thus depicts a world with a grand coalition, this 1^{st}-best-solution means WI = EI = 100%. The Annex B (i.e. the industrialised) states are very close to the inefficient (and ineffective) NASH solution, which suggests that the Kyoto agreement is destined to fail (see section 6). This marks the first striking result. The second conclusion is that some states as a coalition formation manage to move close to the PARETO-solution. Also, removing the EU from the grand coalition means a PIS-coalition with a WI = 92% and EI = 80%. This suggests that the EU is too demanding (see section 3.1), resulting in the tragedy that the US and China do now want to commit to limitation targets under the KP (e.g table 2). A coalition without the EU could result in a smaller coalition consisting of only the US and China (e.g. section 6.2). Even though, the China-US bilateral deal could be stabilised, its WI and its EI is rather low. The most important aspect of IEAs is *effectiveness*, which not only increases with coalition size but also with a specific composition of actors of a climate coalition (see section 7). The question here is whether one single agreement is more effective than multiple agreements [Bréchet and Eyckmans, 2012: 173/175].

Bosetti et al. [2013] explore participation and stability incentives in another IAM, the energy-economy WITCH model, the world introduced technological change hybrid model.[170] The WITCH is able to analyse twelve distinct regions,[171] where economies are modelled in a Ramsey-similar optimal growth framework. The game's outcome is a consumption path over the entire simulation period (up to 2100). In the 1^{st} stage countries decide on coalition membership, and in the 2^{nd} stage both - signatories and non-signatories - choose their optimal emission paths.[172] Bosetti et al. [2013] define the term of a *potentially effective coalition*, PEC in short, which states whether a pre-defined target (stabilise the atmospheric stock of carbon at 550 ppm, which is conform to a warming of 2.4° Celsius w.r.t. preindustrial levels) by this coalition can be achieved or not, and if so in which time period (either at 2050 or 2100). The politically meaningful coalitions are summarised in table 8, where China and India are necessarily needed to obtain

[170] See Bosetti et al. [2006/2009] and $< http://www.witchmodel.org >$ for an overview and other related research papers.

[171] All regions are mentioned in the description below table 8.

[172] Tying in with section 5.3, the game is solved backwards because of the *Stackelberg assumption*.

Table 8: Coalition analysis II

coalition	E
the North only	not PEC
the North + China	not PEC
the North + China + India	PEC (at 2050)
the North + China + India + Russia	PEC (at 2050)
the North + China + India + Russia + Latin America	PEC (at 2050)
grand coalition	PEC (at 2100)

details: The following table accrues from Bosetti et al. [2013: 8] and the table is intended to give trends. Exact numbers of atmospheric stock achievements can be reconstructed from Bosetti et al. [2013]. The acronyms are given as follows: PEC = potentially effective coalition, E = (political) effectiveness, the *North* (as usually) means *the industrialised countries*, which in the WITCH model consists of the USA, Japan + South Korea, EU-15 (Western EU states), EU-12 (Eastern EU states), Australia + Canada + New Zealand. The grand coalition means in the above table the North + China + India + Russia + Latin America + Sub-Saharan Africa (without South Africa) + the Middle-East with North Africa + South East Asia. Russia is referred to TE (transition economies), India to South Asia [Bosetti et al., 2013: 8]. High climate damages and a low discount rate w.r.t. damages are assumed for deriving table 8 (the stated coalitions highly depend upon climate damages). Climate damages if assumed low could in this regard not be effective if compared to high damages [Bosetti et al., 2013: 9]. The same logic works with a low discount rate of utility (i.e. consumption), and thus a high discount factor, where future damages highly matter.

a PEC [Bosetti et al., 2013: 8]. This is the first crucial result. Thus a coalition consisisting of only the North, or one of only the North with China, is not able to achieve the 550-ppm-target at 2100. Three coalitions manage to stabilise at 550 ppm at 2050, and where stabilisation achievements get better if more actors are included in the coalition. Only the grand coalition is potentially effective and achieves (even <) 550 ppm stabilisaton at the 2100 horizon. However, such a grand coalition is never stable. A stable coalition manages to stabilise around 518 ppm in 2050 and 600 ppm CO_2e in 2100 [Bosetti et al., 2013: 1]. This marks the second crucial result. Thus, if global warming is not to be exceeded by $\sim$ 2° Celsius it needs the cooperation and efforts of *all* countries, regardless of any stability conditions.

As coalition size outcomes are usually very small, there are approaches to construct international climate coalition models, which specifically try to raise this same number. The most important instruments to raise the cooperation number is to include explicit side payments and issue linkage [Barrett, 1997c, Carraro and Marchiori, 2003; Carraro and Sinisalco, 1998: 565]. The results on the size of the coalitions very much depend on the slope of reaction functions (best response functions), and thus whether *carbon leakage* exists.[173] Carbon leakage asks for the abatement behaviour of another country if a given country increases its own abatement. If coalition members increase their abatement or if more countries join a treaty, then a fringe member has an incentive to lower its abatement [Carraro and Sinisalco, 1993; Hoel and Schneider, 1997].[174] Furthermore, endogenously derived technology variables or R&D incentives are important in coalition models, since e.g. technology-based agreements (to prevent climate change) imply similar free-riding incentives as conventional agreements, because a free-rider would benefit from green technology innovations without paying for it [Barrett, 2006/2012]. Thus, technology spillovers should only happen between members from the coalition [Buchner and Carraro, 2005].

The assumptions of SPs (as in section 5.2 and 5.3), is a very controversial assumption [Bosetti et al., 2013: 2], and therefore the theoretical conclusions might not even be practically relevant.[175] Countries are different to each other w.r.t. the degree of economic and social development, and are differently vulnerable to climate change because of geographic factors [Hoel, 1992: 142].[176]

Further, whether SGs or DGs should be analysed is crucial. According to Long [2010: 51] it is important to study IEAs statically. Nevertheless, it is important to formulate models dynamically since stock pollution happens intertemporally. The relationship of abatement or cooperation incentives and the atmospheric carbon stock, in this regard, is certainly positive. Moreover, politics are dynamically driven, since politicians or government's positions change and delays occur.

Uncertainty should be addressed more often [Dellink and Finus, 2009; Kolstad, 2007].[177] Uncertainty regards things such as future emission paths, climate dam-

[173]See $< http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=397 >$.

[174]For example, Germany commits itself to abatement, but at the same time other laggard countries do not, or have even higher incentives to not commit (since Germany's abatement efforts affect them in a positive way, allowing them to emit even more). Further, a very high carbon price could in this sense have significant carbon leakage impacts, where countries would change its production place to countries with lower pollution standards (i.e trade leakage, pollution havens).

[175]However, for APs analytical results are hardly ever derived. They can only be partly solved with a simulation, which in turn reduces their validity (see tables 7 and 8) [Stoschek, 2012: 40-41/71].

[176]SIDs such as Tuwalu are especially vulnerable and have a much higher marginal benefit from climate policies.

[177]Uncertain drop outs of players could be modelled in future research, e.g. Russia is very unpredictable, and Canada unexpectedly dropped out of Kyoto in December 2011. Or stochastic

ages, the likelihood of catastrophic climate change, or discount rates to name a few. Associated with *dangerous* climate change events, Milinski et al. [2008] examine cooperation formation in economic decision-making.

Effective treaties should deter non-participation (free-riding) and promote compliance [Barrett, 2005, 1994: 878]. Kyoto fails for such exact reasons; it does not deter non-participation nor does it enforce compliance. If marginal abatement costs ($MACs$) are low and marginal abatement benefits ($MABs$) are high, cooperation can easier be sustained [Barrett, 1994]. This exactly conforms with the success of Montreal, which is benign, and the failure of Kyoto, which is malign (see section 6.3). If the ratio between MAC and MAB ($\frac{\partial C(q_i)/\partial q_i}{\partial B(Q)/\partial Q}$) is small,[178] then cooperation is much easier.

6 International climate cooperation, alternatives, the difficulty of saving the planet and lessons learned

6.1 Conduct of negotiations

Environmental negotiations refer to the procedure where countries build shared arrangements for managing the environment. Global negotiating involves $\geq$ *two* countries aiming to put distinct positions into *one* agreed decision, i.e. the agreement or the accord [Zartman and Berman, 1982: 1]. But, *multi*lateral environmental agreements (MEAs), as is the case for climate change agreements, correspond to the procedure of simultaneously happening negotiations, requiring $\geq$ *three* states over $\geq$ *one* item aiming at *one* agreement [Hessel, 1998: 171; Nyerges, 1998: 177; Touval, 1991: 351].[179] The most frequent treaty rule is obtaining consensus where abstention is an affirmative vote, not a negative vote [Zartman, 1994: 5]. When parties arrive to a commonly accepted decision (inter-

processes could be addressed when modelling functions with stock variables (e.g. the natural decay rate) in dynamic games.

[178] The (aggregate) ratio is stated for SPs. For APs the ratio would be $\frac{\partial C_i(q_i)/\partial q_i}{\partial B_i(Q)/\partial Q}$ [Barrett, 1997c: 20].

[179] However, most of the times multilateral environmental negotiations (MENs) are about the question of *which* issues should be negotiated on [Chasek et al., 2012]. Also, bandwagoning gives other items on the agenda to profit from the (political) attention created, generating impetus, or allowing for issue linkage [Jinnah and Conliffe, 2012: 199-121; Stoschek, 2012: 149].

national agreement), the latter has to (or should) be ratified and implemented on the national level by each party. However, states are not the only actors in the game affecting policy outcome. There are also actors from the non-governmental sector, and most importantly the industry sector, and the secretariats (standing behind the UNFCCC and managing climate regime governance), which all play a major role in influencing a state's position [Chasek and Wagner, 2012: 8].

The *busy* climate change calendar of the UNFCCC is supposed to reflect the modern institutional framework for supporting and monitoring (climate) MEAs and their launching. Although, this intensification has created diffusion of agenda items and documents, informal groups, and even climactic late nights [Chasek and Wagner, 2012: 10; Depledge and Chasek, 2012: 19]. Information-related technological progress has, moreover, facilitated environmental communications. This notable phenomenon of intensified MEAs is attributed to several causes, which in turn define the effectiveness of international environmental policy-making. Those causes are: a greater amount of treaties handled (more and longer documents), and more meetings in a particular time period (busy calendar). The latter, most absurdly, also incorporates a huge carbon footprint. Michaelowa and Lehmkul [2005: 340] estimate that 15 years of environmental negotiations had (up to the year 2005) contributed to $\sim$ 150'000 t CO_2, which approximately is the amount of the yearly carbon impact of a small island state like Samoa. Other causes include the greater amount of items/issues on the agenda. Especially since 1997, this cause has become more significant. New UNFCCC-related items include CDM projects, forest principles and soil-related issues, as well as CCS (carbon capture and storage). Few items have been fully *closed* up to now. Thus they never retire, which adds up even more to the pile of items. The CBD, for instance, has added the subitem of geo-engineering or biofuel.[180] Such specialisation is slightly unfortunate as it makes implementation more complex. The fact that $<$ 2% CDM-projects were done in Africa proves this [Collier et al., 2008: 350; Depledge and Chasek, 2012: 25]. Furthermore, what does not help MENs is the greater number of participating actors as well as time compression: What can be associated with the particular cause *time compression* is the term *negotiation by exhaustion* [Depledge and Chasek, 2012]. There are many all-night-meetings, and conferences often end much later than scheduled (as was the case in Doha 2012). W.r.t. the raise in the number of stakes, such as ministers and heads

[180]See < *http://www.cbd.int/climate/geoengineering/* >.

of state, which are taking part in today's negotiations, Schroeder et al. [2012: 835] give an overview on how many delegates attended each CoP-meeting, e.g. France was represented by a remarkably large number of delegates at Copenhagen. Further, because of too many meetings all around the world, there are many similar mandates. Smaller negotiations cannot survive anymore. Najam et al. [2006: 14] note that the observed intensification even leads to a fragmentation resulting in duplicative meetings and inconsistencies. Part of this problem has been attempted to be solved by overlap management, which means decreasing duplication and exploiting synergies [Jinnah, 2012: 108].

Whilst the pace of MEAs has fastened, the speed of real advances has declined in the last 20 years [Depledge and Chasek, 2012: 36-37].[181] What constitutes the probably greatest threat is that intensified activity, shown in political attentiveness and force, gives a rope of sand of real advancement covering the proceeding emissions. It seems that governance is busier with holding regular negotiations (by presenting a *busy* UNFCCC calendar) than with ensuring *real effect* (see section 7 for effective problem-solving). This same intensification, accompanied by all its drawbacks, leads to the question of whether the current climate regime, as it operates today, is the right path (see sections 6.2-6.4).

6.2 Alternative paths

Multilateral environmental agreements (MEAs) were established more than thirty years ago and have dominated the political agenda ever since.[182] According to the UNCED (UN Conference on Environment and Development), the total of MEAs and meetings number approximately > 1000.[183] Although several of them have affected things positively, the overall impact w.r.t. climate change is very low. International climate agreements are currently stuck in a state of deadlock. In particular, as MEAs have intensified in number, the burden of negotiating (the environmental problem-solving) has become more difficult [Munoz et al., 2009]. At the moment, the world is far away from any climate regime to decrease the rising stock of atmospheric carbon (and other GHGs), and alternative paths may

[181] The ENB [2010a] investigated whether progress in climate change was a slow tortoise or a hamster in a spinning wheel - both indicating to come eventually nowhere because of either being too slow or too inefficient.

[182] For a detailed set and timeline of MEAs consider Chasek and Wagner [2012: 4-6].

[183] See $< http://iea.uoregon.edu/page.php?file=home.htm\&query=static >$.

have greater results.[184]

A few countries are endeavoured to seriously abate global warming (e.g. table 2). The majority of them, however, are not keen on any remarkable climate policy at all. The political problem is to move from this state of deadlock to (another better) one via establishing stringent and, most importantly, viable universal mitigation policies. This means to achieve large-scale GHG cuts, and thus a transformation of the entire energy system. The political strategy should motivate R&D investments into clean technologies, and thus (because of its substantial cost size) be cost-effective. It should create participation incentives throughout. The present structure involves the UNFCCC and the Kyoto framework. By asking which international political strategy is optimal, a reassessment of the current universal framework must be made.[185] This first approach (*a*) regards the elimination of the flaws in both treaties [Dessler and Parson, 2006: 110-115]. For the KP this means to state advice for implementing GHG cuts and thus install the policies needed in every country (see section 6.4). For the UNFCCC this means to overcome procedural approaches (see section 6.1). The second approach (*b*) regards a complete departure from those bodies to a completely new architecture of agreements and/or set of actors [Dessler and Parson, 2006: 163-164]. According to Desslar and Parson [2006: 166-167] there are two possible ways for (*b*) (and thus for moving outside the KP): these include either to build a market for emission rights beforehand *(I)*, or to create different coalition structures *(II)* (as tables 7 or 8 suggest). *(I)* would mean that the EU-ETS is dropped in favour of a better *global* trading regime, and that targets are discussed *after* the establishment of the quantity-based market, where its goal is to *control emissions* (see section 4.1). The same notion comes from Keohane and Victor [2010: 21-22], who say what could constitute a better regime complex is an improvement of the *international* ET since this policy instrument has become the major approach for addressing demanding changes.[186] *(II)* could happen in two different ways: either via an exclusive bilateral deal between the two giant actors US and China *(i)*, or via the formation of a relatively small unit of rich, developed, and similarly

[184]The following paragraph is based on Dessler and Parson [2006: 162-174], if not mentioned otherwise.

[185]However, amendments to the (UNFC)CC are very complicated as they require affirmation of most parties and, if adopted, still have to be ratified by the parties willing to commit to those [Pereira and Jourdain, 2012].

[186]Note at this point that the EU-ETS has not evolved under Kyoto suggestions for an ET scheme (see section 4.1).

located states, which are most determined in combating global warming and thus establishing a serious mitigation regime (e.g. Germany, the UK, Norway, Sweden, Switzerland and so on) *(ii)*. Regarding *(i)* w.r.t. bilateral US-China agreements Stewart and Wiener [2003] argue that the US should take their political position with more leadership and set up an ET scheme whilst taking China's growth interests into account and, in this regard, renegotiating joint emission limits. Other climate laggards should (later on) be included in the ET scheme. The benefit is that a bilateral deal would be much simpler than attempts to negotiate globally (as under the KP), where the EU is a very demanding actor and hence hinders the inclusion of climate latecomers (e.g. table 7). As Dessler and Parson [2006: 169] strikingly state it is "the unwillingness of each of them [of the US and China] to participate [and that same unwillingness could be] (...) overcome by securing the participation of the other". *(i)* thus contains promise since the resistance of China or the US (to join anything similar to the KP) remains a major problem under the current framework. But, because a coalition between the US and China incorporates a very low welfare as well as environmental index (e.g. table 7), and because it is intuitively appealing that if India, the EU, and other major climate actors will not be integrated, setting up a unique and comprehensive global regime will virtually be impossible. This leads to the suggestion that what would consist of perhaps the most promising way to abate global warming is *(ii)*. A *coalition of the willing* would be best formed by those states that have shown the greatest efforts so far, e.g. the EU. This coalition of the willing would negotiate short-/medium obligations to achieve the ex-ante initiated long-term target.[187] What is essential is a global coordination of the mitigation regime, which does not have to happen immediately (when forming the willing coalition). Narrowness of the initial coalition means more focus and strictness among the members, and this advantage might be bigger than the universality advantage of the KP, where its broadness risks its being dispersed. What has been argued is that the current framework is ineffective [Victor, 2006]. Thus, if moving outside the KP, one has to be sure that the coalition of the initially willing states has the possibility to get bigger (and not block a following expansion of the coalition), and hence become effective (have a significant impact on GHG emissions) (see section 7). For this, the initial, small-sized, rich-state coalition would have to

[187] Such an approach would, however, involve risks like ineffectiveness (when the coalition is too little), political insustainability (when competitive disadvantages are so high that the coalition cannot survive), or inconsistency (blocking of a further expansion of the initially little coalition) [Dessler and Parson, 2006: 170].

be established relatively quickly in order to signal serious commitment and not bickering, which has recently been observed among EU actors [Dessler and Parson, 2006: 172]. To achieve further effectiveness, initial policies would have to be designed accordingly, to create the right incentives for participation of other states later on. Desslar and Parson [2006] and Stiglitz [2010] state that the coalition's initial mitigation agreement must set up trade measures (see section 6.4) which would either include a border-tax adjustment equalising the associated policy costs from out-of-the-coalition-exported (off-shore) and into-the-coalition-imported goods *(1)*, or require imported goods to buy emission certificates and offshore-goods to receive emission certificates *(2)*. Resistant competitive drawbacks could be effectively reduced in this way. *(1)* involves a per-unit-CT on goods (a price policy), where imported goods are taxed to the same degree as onshore (domestic) goods, and where the CT gets rebated in off-shore-trade. *(2)* is a tradeable permits scheme, and would work exactly like *(1)* with the mere difference of using a quantity approach instead. A border adjustment (based either on *(1)* or on *(2)*) would have to quantify grey emissions (attributable emissions from production to consumption-state, see section 3.1) very carefully, and similarly involve challenges in data collecting and monitoring. The biggest challenge would, in this sense, entail the transformation of the WTO with respect to grey emissions (see section 6.4). Both trade measures should put a heavier burden on non-coalition industry countries (e.g. Canada) than on developing countries (e.g. India), for which the trade measures could even be set to zero at first for the latter (total drop of trade measure for non-Annex-B countries). Illuminating *(i)* and *(ii)*; a coalition of the willing would not mean to exclude or be incompatible with the proposal of USA-China bilateral treaties, or be incompatible with a merger of the KP afterwards.[188] *(ii)* requires much political effort in the initialisation of the first willing states to the coalition. A later aimed expansion for global participation of the coalition would mean thorough negotiation between the inital coalition members and the South especially. What the authors further state concern about is the uncertain outcome of EU-USA relations; the EU wants to have very strict mitigation targets - something the US does not want to have. Summarising the thoughts above, while many of the political strategy sketches or policy proposals stay inauspicious, *(i)* and *(ii)*, nevertheless, resemble two approaches which hold at least some future promise. And the latter, *(ii)*, perhaps suggests even more

[188]However, if merged with the KP again, individual commitments/targets should not happen according to ex-ante negotiations (as is the case now).

promise as it would pledge for strict mitigation targets (in the long-term) and adopt measures in trade [Dessler and Parson, 2006: 176].

The current architecture has not only been contested by scientists and several governments, but also by the UNEP and the UN General Assembly itself [Chasek and Wagner, 2012]. As the literature on alternative governance forms is rather widespread [Harris, 2011; Young, 2011], not all alternative paths are discussed at this point. Speth [2007: 16-17] states that there are, in general, two basic strands of institutional reforming: improvisation of the climate regime *(A)* (similar to (a)) or a complete change, which goes to the core of (solving) the climate problem (B) [Prins and Rayner, 2007]. People who support *(A)* believe that the international environmental law as it is constituted today, is the proper path. On the other hand, people who endorse (B) believe that much deeper changes are necessary. In the following, mainly (A) is discussed (see section 6.4) as exploring *(B)* would involve analysis, which goes beyond the scope of the here-presented contents,[189] since it believes that globalisation is intrinsically destructive for the environment, and thus implies the same as to the formation of the entire capitalistic market economy:[190] Lovins and Cohen [2011] state in this context that *respect for nature, universal human rights, economic justice, and a culture of peace*, following the words of the Earth Charter, are urgent.[191] Similarly, Keohane and Victor [2010] state that any efforts to establish an effective and rightful regime is not possible without changing the underlying problem behind it. Stern [2009] notes that climate change is the most far-reaching market failure so far, and since regulation is inevitably needed to handle climate change, it constitutes the biggest threat for the ideology of free market fundamentalism. This can explain behaviour of climate sceptics, which deny climate science since they believe in free markets (see section 6.3).

Some scientists expressed the idea of setting up a World Environmental Organisation (WEO), similarly to the WTO [Andresen et al., 2012: 190; Chasek et al., 2012: 260; Helm, 2008: 220; Mitchell, 2010: 196-197; Speth, 2007: 16] for strengthening *environmental policy* besides *economic policy*. Handling climate change under a unified organisation could perhaps handle the considerable amount of MEAs and synergies between these more effectively, and thus bridge the gulf between *outcome* or *output* and *effect*, meaning that Kyoto has not made

[189] But section 6.4 gives concluding remarks on (B), as well.
[190] See e.g. < *http://www.ifg.org* >.
[191] See < *http://www.earthcharterinaction.org/content/pages/read-the-charter.html* >.

any noteworthy difference in protecting the climate (see section 7). Another idea would be the creation of a world environment agency (WEA), which would be responsible for setting up and enforcing effective, global standards [Speth, 2007: 16].

Besides reforming the global climate governance framework, the focus can also be put on a *bottom-up* approach, where doors would be openend for the public to take part in decision-making [Speth, 2007: 16]. Thus the current idea regime of "think globally, act globally" would somehow be replaced by "think globally, act locally". The World Intellectual Property Organisation (WIPO) could act as a role model for that [Estrada, 2012: xvii]. Similarly, a *Global Issue Networks* could work, since the potential in a world outside governments is immense [Rischard, 2002].

Reorganising the institutional framework (A), is essential. This should happen soon because any further procrastination of moving along an *ineffective* path of problem-solving is dangerous, and the longer society waits the more cost-intensive and difficult climate change abatement will become. Stiglitz [2010] states that the KP was given more than a fair chance. There has been no decline in total emissions since the climate regime under the UNFCCC with the KP had been introduced. At this point, one can counter that total emissions would have risen more than they have happened to rise so far, if the KP had not been made. But this constitutes a weak argument. Perhaps the only achievement of the KP is that it contributed to the establishment of the EU-ETS. The KP has failed both - horizontally and vertically [Boehmer-Christiansen and Kellow, 2002; Hanf and Underdal 1998]; horizontally because key climate actors are not included and vertically because policy outcomes are too lax. That is why it should be worth giving the alternative a proper chance.

6.3 The malignance of climate change

Amongst all environmental troubles, climate change definitely is most *malign* [Andresen et al., 2012: 173-191]. The reason is that the *initial* conditions for addressing climate change are absolutely unfavourable.[192] An issue is malign if

[192] Hardin's [1968: 1244] depiction of a public good certainly applies here that "(...) ruin is the destination towards which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons" denoting that in the case of climate change one has a *tragedy of the atmosphere*.

it exhibits asymmetries, uncertainty, and political disputation, and thus needs to be solved collectively [Andresen et al., 2012: 9]. In the case of climate change, the famous environmental Kuznets curve[193] does not even apply, which wholly militates in favour of a malign problem [Bernauer and Schaffer, 2010], since the greater $\frac{GDP}{capita}$ the greater the carbon footprint (recall table 3) [or Millimet et al., 2003; Galeotti et al., 2006; Holtz-Eakin and Selden, 1995; Dinda 2004; Neumayer 2002].[194]

Ozone, on the other hand, is benign [e.g. Sunstein, 2003]. There are several reasons why the MP succeeded and the KP has not so far [Barrett, 2005/2008: 248-249; Bernauer and Schaffer, 2010: 13-14], even though both represent not only *transnational* but truly *global* public goods. The effect is not dependent on where CO_2 emissions or discharge of CFCs happens. Only geographic regions matter as to how vulnerable a state is. For instance, over Australia the ozone layer is very thin, whilst Tuwalu or the Maldives are especially vulnerable when considering climate change. One crucial difference is that ozone depletion affects all countries,[195] whereas *catastrophic* climate change (caused by tipping points [Lenton et al., 2008]) would harm all states as well, but *gradual* climate change induce winners and losers [Barrett, 2008: 248], e.g. the South is more vulnerable to climatic change than the North. It is, furthermore, agreed that ozone damages are considerable in the short-term (e.g. skin cancer, crop destruction), and that producers of ozone-depleting substances (ODSs) were very concentrated (USA, Japan, Russia, the EU), and that these same substances could easily be substituted without high costs and managed to open new markets [Oye and Maxwell 1994: 595-598]. But for climate change, large-scale substitutes are still not really available, and renewables and green technologies are very expensive; in general, benefits and costs do not look similarly attractive [Barrett, 2007]. If climate change abatement fails, the world faces medium to long-term damages, which are

[193]The KC, according to Kuznets [1955], states that there is a U-shaped relationship between the stage of economic development and income inequality. Industrial nations are placed around the curve's optimum, whereas pre-industrial ones are placed to the left (positive slope) and post-industrial nations to the right of the turning point (negative slope). The KC has been applied to environmental economics where the dependent variable (income inequality) is replaced by environmental degradation/pollution.

[194]The same pattern of a convexly rising pattern happens to be with the amount of waste. This stands in contrast to which the EKC applies, e.g. deforestation or concentration of SO_2 in cities [e.g. Lempert et al., 2009]. This also stands in contrast to particle pollution in cities, where one observes a falling relationship, and which also militates in favour of a more benign problem [Lempert et al., 2009].

[195]That is why mitigation has been better than adaptation in the case of ozone.

hard to quantify. In literature, future damage costs highly vary [Nordhaus, 2010; Stern et al., 2006; IPCC, 2007a]. McKibben [2012] goes so far in saying that the climate *game* is one with terrifying trillions to play. Not only are *damage* costs very uncertain, but there are different scenarios for *mitigation* and *adaptation* costs as well. In the case of the ozone hole, mitigation costs are $ < 10 billions, where the phase out costs occur over $\sim$ maximally three decades. But in the case of climate change, mitigation costs amount to $ multiple 100 billions, and costs occur over certainly more than three decades [Bernauer and Schaffer, 2010: 14].[196] Last but not least, even if the IPCC provides scientific evidence for global warming - and scientific evidence was also given in the case of Montreal - political and financial counterforces are too much at play. The South wants to reach the same level of economic wealth as the North, but the sheer complexity and heterogeneity of interests hamper an effective agreement between both sides.

As section 5 displays, there is a great free-rider problem in the case of climate change, and cooperation requires the efforts of all countries, which also means efforts from all producers and consumers of fossil fuel; all which give fuel to a globalised industrialisation.[197] But IEAs are not self-enforcing (i.e voluntary participation should be incentivised, and negotiations should not be stopped by the least ardent actor), and there is no supranational authority which would do that [Barrett, 2005].[198] While climate change is a *global* problem, individual countries are *sovereign*, and *multinational* companies are transnational and even global again. Barrett [1997a: 241] names that this same self-enforcement distinguishes international from national environmental issues, since for the former the accused actor (e.g. a private firm) can be brought to trial. But regulation in this context also means that national governments separate remunerative activities into the private sector, and non-remurative activities into the non-profit sector [Chasek et al., 2012: 255-256], reflecting that competition and cooperation are two sides to one problem. According to the governance and institutional architecture, Depledge and Yamin [2004: 450] state that the UNFCCC's failure is not attributed to a particular design, but to the exact malignance described above, together

[196] That is why the GCF was set up (see section 2.2).

[197] The less players there would be, the easier would be environmental problem-solving.

[198] A salient attribute always is that IEA membership happens non-compulsorily. This is why only willing players commit to CO_2 targets. It is also clear that voluntary cooperation will never allure all countries to join. If not all countries join a treaty, at least consensus inside a coalition is important [Chasek and Wagner, 2012].

with other complexities, which a *global* regime has to cope with. The malignance, eventually, means that climate change is not only about environment, but also about economic interests, development and economic growth, (energy) politics and trade.

Industry lobbying do not help successful negotiations, either. If corporate interests stand behind then solutions are especially difficult [Chasek et al., 2012: 255]. Exxon, BP (British Petroleum), or Gazprom belong to the most powerful multinational corporations [McKibben, 2012]. Their core business is built upon exploiting fossil fuel reserves. Further, energy concerns belong to the only industry branch, which does not have to pay for its waste caused to the environment (increasing GHGs). The Carbon Tracker Initiative in this regard calculates that the fossil fuel reserves are five times higher than the CO_2e-budget until 2050 to keep global warming under 2° Celsius (which is $\sim$ 565 $GtCO_2$e). 80% of these reserves should never be exploited, but economically they already exist in price of shares and other financial assets.[199] Helm [2008: 212] notes that the reserves are very likely to be exploited because the energy industry will not give up its core business this easily. Curtailing lobbying activity is hard since the rich fossil fuel industry regularly provides funding for *conservative* think tanks, and industry-backed researchers help to completely deny climate change [Dunlap and McCright, 2011: 148]. Curtailing multinational enterprise power remains even harder [Speth, 2007: 16-17]. According to Dessler and Parson [2006: 113] ensuring completeness across country borders is a virtually impossible task, simply because international companies operate *transnationally*, whilst governmental policies operate *nationally*.

Tying in, the interaction of policy and climate science, and scientific uncertainty are other politically troubled matters. Despite the scientific evidence (e.g. of the IPCC) that climate change is anthropogenic, the commodity climate is determined by politics in the end. As Kohler et al. [2012] and Chasek and Wagner [2012: 12] examine, science has failed in overbearing the fundamental differences in economic interests. But not only do economic interests lie beyond the scope of environmental protection, but also the fact that current politicians seek to maximise their votes and nothing else. Poorly written summaries for the DMs by the IPCC, or implausible methodologies contribute to the possibility of failing communication of the climate change topic. Furthermore, the rhetoric of climate

[199] See < *http://www.carbontracker.org* > and McKibben [2012].

science language has not contributed to better decision-making, but created an unfortunate deadlock of mistrust instead [Dessler and Parson, 2006]. It has been seen that describing climate change as *uncertain* has led to understatement of the issue on the political stage, and indicates that *issue framing* plays a major deal. For example, the term *scientific uncertainty* has condemned climate change science to be seen as untrustworthy. As Kohler et al. [2012: 76], however, perfectly state is that "uncertainty is the engine of science [and frankly] (...) what keeps scientific inquiry alive". A scientist's duty is not to do political work and answer every question which politicians pose, nor should it be his task to implement his findings into politics, and thus science should *only* "[speak] truth to power" [Kohler et al., 2012: 61].[200] Fitting into this context, what has been striking (since the Copenhagen convention in 2009 especially) are the so-called *climate sceptics* [Biermann, 2011: 687]. This might also suggest why public pressure for solving climate change has been rather modest (in contrast to the ozone problem) [Nisbet, 2011: 355/358-359].[201] Interestingly, public interest has actually decreased whilst scientific certainty has improved [Norgaard, 2011: 399]. A possible cause for such small public participation is the problem that climate change is a long-term problem - the emissions which are blown out today will affect global warming (and thus only by then become truly *visible* to society) in ~ 100 years. I.e. fluxes are very slow, which thus represents an *intergenerational* problem [Keohane and Victor, 2010: 9]. This also explains that immediate mitigation (starting *now*) would not prevent climate change, and average earth temperature could still rise up to 2° Celsius [WB, 2012]. Sceptical arguments involve:[202]

– Global warming is no output of human activity, and climate science is a lie.

– The rate and level of climate change is statistically not significant; trivia as "the last decade exhibited a negative warming trend". However, because of 2003 being such a hot summer, the linear short-period regression trend from e.g. 2002-2008 was negative. The uneducated person does not take into account that climate change is subject to short-period variance, but certainly not to long-term variance.

– The relationship between the climate system and the amospheric stock of

[200] Consider also Malnes [2006].

[201] A recent study conducted by Credit Suisse in 2012 confirms this trend, where environmental protection ranks almost lowest $< https : //emagazine.credit - suisse.com/app/article/index.cfm?fuseaction = OpenArticle\&aoid = 376126\&coid = 377345\&lang = DE >$.

[202] The presented arguments are partly drawn from $< www.climate - skeptic.com >$.

CO_2 is overvalued, and the planet's balance cannot be that easily disturbed, especially not in such a short time period. E.g. *The skeptical environmentalist* by Lomborg [2001] points that climate change as a problem itself is hyped-up.

– The IPCC presents defective results such as the *hockey-stick-curve* [Hajer and Versteeg, 2011: 90-91].

– As climate scientists are uncertain themselves, there is no reason to be concerned about global warming (position of the US Bush administration in 2000-2008) [Kellow and Boehmer-Christiansen, 2010]. Rogelj et al. [2013] state that such *scientific* uncertainties often led to *political* inaction in the past. Political uncertainty is thus the biggest aspect in climate uncertainty.

6.4 Lessons learned

Since Kyoto is the only game in town at the moment, and since an *international* Kyoto is expected to enter into force by 2020 (e.g. section 2.2), Barrett [2008: 249] states that one should learn from Montreal's success. To compare with, the MP entered into force in 1989, and the first countries, which ratified it, were responsible for $\sim 80\%$ of global emissions of ODSs at the time.[203] The MP solved the ozone problem almost completely. The same cannot be said for Kyoto, even as its extension has remained uncertain, at Doha 2012 (e.g. section 2.2). Kyoto should, in this regard, not try to reduce GHGs by some pre-defined amount on some pre-defined date. The same holds for the European climate and energy package with its $20-20-20$ targets for 2020, which merely typifies a short-term solution for a long-term challenge [e.g. Helm, 2008: 230-233]. Montreal's limits are permanent, and targets are designed not for only one CP; that is perhaps the most crucial reason why the MP succeeded.

Further, the KP should effectively create technology innovation and adaption incentives (as did the MP). Andresen at al. [2012] state that technology is most important for a long-term solution, and cutting back carbon with appropriate technology would not cost the world. Innovation and adaption need price incentives (see section 4.1). However, investments into R&D are very low at the

[203]See < *http://ozone.unep.org/new_site/en/montreal_protocol.php* >, and recall that the KP commitments come from countries which only hold $\sim 15\%$ of global emissions (e.g. section 2.2). For the analysis of the *effect* of the MP on the ozone consider Velders et al. [2007] (see section 7).

moment and have significantly declined in the last few years [Hepburn and Stern, 2008: 274], but investment into technology is fundamental [Keohane and Victor, 2010: 21-22].[204] Barrett [2010] states that "the climate, technology, and our institutions will co-evolve". In this regard, *inclusive* institutions [e.g. Acemoglu and Robinson, 2012], would be able to put through direct mitigation strategies [Helm, 2008: 220]. But again, setting up institutions could only happen via voluntary negotiations, and if countries cannot even settle on national strategy enforcement it is highly controversial as to why they should think of fully giving away their authority to some global institutional body [Dessler and Parson, 2006: 114-115].[205]

The KP is surrounded by further flaws, which Montreal happens to overcome [Barrett, 2008: 248-249; Buck and Yandle, 2001]. Montreal also includes consumption limits on ODSs (production plus imports less exports), and thus takes grey emissions into account. Furthermore, the MP requires not only developed states but also developing countries to reduce ODSs. This means that even though, historically, the wealthy countries have emitted the most, the emission trend of the South is increasing [Rogeberg et al., 2010], and *adverse* trends heavily militate in favour of the inclusion of the South in climate treaties.[206] If this is not achieved, any attempts of policy interventions by other players will be in vain. Carbon leakage yields the same. Consensus has become the process for decision-making. For legally binding contracts, the consent of every negotiating actor is needed [Estrada, 2012: xvi]. Maybe a majority vote (as is already used by the EU and the JUSSCANNZ) would help to get more people on board. To get the South on board, help via finance is necessary. Further, cooperation incentives depend positively on (future) benefits, which suggests the better capturing of the latter. Breaking the issue in smaller parts (such as sectors and gases) could also be a step into the right direction [Barrett, 2005/2008].

Trade restrictions as amendments to the WTO are considered very important [Frankel, 2008]: The Protocol bans ODS-trade between signatories and non-signatories, thus trade leakage is overcome. W.r.t. the climate regime this sug-

[204] One shoud bear in mind that induced by population growth or "fancy" technology, there can be a crowd (rebound) effect w.r.t. energy efficiency so that the effect of saving CO_2 is much smaller.

[205] However, this is actually exactly how the WTO has evolved $< http : //www.wto.org/english/thewto\_e/whatis\_e/who\_we\_are\_e.htm >$.

[206] See section 3.1, tables 2 and 3, and recall that KP-participation is global, but commitments are heavily differentiated.

gests better interconnections between the WTO and MEA secretariats. The KP in general does not address trade properly and gives only vague formulations on issues and climate measures related to trade [Kulovesi et al., 2012]. The WTO and MEAs show legal differences such as institutional constraints, and discussions about trade and environment will not go away any time soon. Historically, trade enjoyed a bigger role than the environment; access to new markets and trade liberalisation were key reasons for this. Stiglitz [2010] notes that many leaders, in the US in particular, appear to fear competition from emerging markets if they face border taxes on carbon-related imports from countries which do not have to pay for carbon emissions. Keohane and Victor [2010: 21-22] come to the same conclusion and write that border tax adjustments would yield to trade discrimination and hinder successful cooperation.

Finally, Montreal achieves in creating strong compliance and participation incentives, which have managed to decrease ODSs *substantially* [Barrett, 2008: 242-244]. Unsurprisingly, the ozone regime has the best and most detailed obligations, rules, and sanction mechanisms - something which the KP does not have [Barrett, 1997a: 252, 2002: 542]. The same happens to be with the WTO, which has an enforcement system via sanction mechanisms [e.g. Barrett 2005/2007b, Stiglitz, 2006]. If somebody leaves the KP (*freeriding alpha error*) or does not meet a target (*freeriding beta error*), there are no significant sanctions for the same, so compliance under Kyoto is not ensured, and parties are not likely to support binding compliance in the near future.[207] However, to achieve that very same (monitoring and verification of complying to rules in climate change) is particularly hard for the South. Punishments appear very important for an effective solution in the long-term [Brekke and Johansson-Stenman, 2008].

Strong leadership is required to solve the climate case [Estrada, 2012: xvi], where power plays a major role [Andresen et al., 2012: 10; Andresen, 2007]. Not only should the EU be a leader, but so should important economies like the US or Japan, as was the Montreal case.

As is addressed in section 6.3, the way how scientists deliver their information to decision makers is a big indicator for the success of MEAs. Besides the salience of advice, the credibility, and legitimacy (the latter meaning the take-up of information for the DM) is most relevant according to Cash et al. [2003]. Since the Earth

[207] Barrett [1991: 210] differentiates in this sense between *freeriding alpha* and *beta error*.

Summit in Rio, three factors $(i) - (iii)$ contribute to the success of persuading DMs [Kohler et al., 2012: 69]. First, expert identity (i) matters greatly.[208] Second, experts and scientists cannot give answers to everything (ii) (see section 6.3). Third, advice must be given in the way that it fits the political spectrum (iii).

Globalisation and international environmental problem-solving are coupled in a way where the former affects the latter via democratic society, international trade, finance, and economic growth.[209] The biggest clash seems to be between preserving the environment and economic growth. According to Escobar [1996: 328] sustainable development is compelled to propitiate two old enemies, which are *growth* and *environment*. However, nothing is done w.r.t. changing the current social market economy. What is, however, done, is the reverse - where climate policy instruments are built to fit the current market reasoning (i.e. they are market-based, see section 4.1). The markets, as they are today, cannot include the component of protecting the planet, and they should be significantly reformed. This idea has been widely suggested by many renowned scientists such as Tim Jackson [2009] to name one. Stiglitz [2010] alludes to the absurdity of helping out banks during the economic bailouts in 2008/2009 by transferring them hundreds of $ billions, but the sad condition that not one is willing to give "something more to save the planet". Building on, figure 4 depicts the night lights (in 2003) captured by the National Oceanic and Atmospheric Administration (NOAA) Geophysical Data Center (NGDC).[210]

Figure 4 depicts a clear image of night time lights and thus CO_2 emissions in concentrated parts of the world. It is intended to show that the countries which are most developed show the brightest areas of night time lights, which positively correlate with their carbon footprint (as table 3 suggests). It is, moreover, intended to show that global warming is driven by the behaviour of (almost) all countries, and that society would have to completely change its consumption behaviour of

[208] E.g. the IPCC consists of a greater number of developed country scientists (North), and the South is underrepresented [Biermann, 2006]. The South accused the North that the IPCC would thus not properly differentiate between *survival* and *luxury* emissions which (have) yielded to a fierce North-South conflict. The South was convinced that the North was trying to block their economic growth.

[209] For an outstanding overview about climate change and society consider Dryzek et al. [2011].

[210] In 2013 the figure's white areas should be even brighter and larger (especially for China) since emissions and energy consumption has risen since 2003 [IEA, 2011/2012].

Figure 4: Night time lights

source: NOAA Geophysical Data Center, DMSP-OLS nighttime lights time series < *http : //www.ngdc.noaa.gov/dmsp/downloadV4composites.html* >.

energy or energy-related products to solve global warming, which remains virtually impossible (as would be to turn off all nighttime lights). Keohane and Victor [2010: 9] note that "(...) changing practices w.r.t. climate change requires changes in the habits of billions of people [and] firms". Population growth and the developing countries wanting to reach the same status of wealth as the developed countries will contribute to the difficulty of trying so. Najam et al. [2007: 21] get to the heart of the matter by stating that consumption, of both South and North, will define the future regarding globalisation *and* the environment.

7 Conclusion

Climate change treaties should be *effective*. Climate research and politics should be the same. Underdal [2002: 6-7] in this sense distinguishes between *output, outcome,* and *impact*. Output describes international regulations or treaties, and national policy-making or target commitments. The end product of output is outcome, which is more about climate regime implementation, when policy measures operate. The above thus explores the stringency of climate policies, the inclusiveness of rules, and cooperation incentives. Outcome is also about adaption of states to a *greener* environment, where changes in behaviour occur. Finally, impact is the change of the environment w.r.t. human behaviour change and for which the MEA was created, and thus represents the *effect* on total annual CO_2 emissions or the rise in the atmospheric carbon stock, respectively. Thus, outcome (and even output) are more about potential than actual effectiveness. Bernauer [2010: 15] states that research at the moment focuses either on output or outcome. Political scientists and international relations researchers are more occupied with exploring output [e.g. Bernauer et al., 2010; von Stein, 2008], whereas economists try to explore outcome (see sections 4 and 5).

The preceding thesis tries to combine the various political and economic sides on the topic *climate change*. What can be concluded by the contents analysed is that future research, especially among economists, should place a much higher focus on the relationship of *outcome* w.r.t. *effect*. Bosetti et al. [2013] for instance conclude that the only *effective* coalition is the grand coalition, which is similar to the ambitions of establishing a global contract by 2020 (see section 2.2). It is therefore crucial for economists to investigate cooperation incentives. E.g. the grand coalition in table 8 is not stable, and some people believe there will never exist something like a global climate contract (or certainly not by 2020). Altering such incentives would suggest changes to the framework, which would ultimately yield to changes in behaviour (see section 4.1).[211] The climate game is nothing else than the failure of setting the right incentives.

As the preceding thesis unravels, politics definitely play the major part in solving climate change. According to Rogelj et al. [2013] politics is the main uncertainty factor in determining *effect*.[212] But politics is usually not accounted for in climate-economic models. Even the IPCC does not properly account for it, and estimates carbon trajectory paths for the future by only taking exogenously given key assumptions without considering *political scenarios*.[213] Future climate research should thus start to account for politics since it drives technology (e.g. investments into R&D and its implementation), compliance, finance, social perception, and many things more, as well as eventually *impact on the climate*.

[211] This is the same as bridging the gap between micro- and macroeconomics, since only microeconomics (e.g. game theory) manages to investigate behavioural changes (i.e. *outcome*), but only macroeconomics manages to analyse global relationships and thus the global effect on e.g. emission paths (e.g. *effect*). Therefore, in order to perform strong macroeconomics, understanding the world of microeconomics is crucial.

[212] See < *http : //www.nature.com/news/politics − is − biggest − factor − in − climate − uncertainty* − 1.12138 >. According to Rogelj et al. [2013] "the big finding is that the choice of when to do something influences the [effect] much more than (all other) uncertainties".

[213] Consider the Special Report on Emissions Scenarios (SRES) via < *http : //www.ipcc − data.org/sres/ddc_sres_emissions.html* > and Nakicenović and Swart [2000].

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