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A practical approach to offset permits in post Kyoto climate policy

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Economic Research

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Non-Technical Summary

In recent years, the parties of the United Nations Framework Convention on Climate Change (UN-FCCC) failed to negotiate a follow-up agreement of the Kyoto Protocol. The commitment period of the Kyoto Protocol ends in 2012. Without a post Kyoto agreement there are neither binding emissions reduction targets for the period from 2012 onwards, nor is there a clear framework for the generation of carbon offset credits from emission reduction actions in developing countries and emerging economies. In this paper we analyse the possible demand and supply for offsets for the period from 2013 to 2020. The analysis is based on the assumptions that developed countries (Annex I) implement the emissions reduction pledges made after the 15th Conference of the Parties in Copenhagen ("Copenhagen Pledges"). Further we assume that international emissions trading will be continued after 2012. For the Copenhagen Pledges to be achieved, Annex I countries need to introduce domestic greenhouse gas regulation schemes. This can be done by quantity regulation (emissions trading scheme) or by price regulation (tax) when the countries are able to purchase international offset credits. In addition, we assume that Annex I countries aim to keep the costs of regulation (e.g. price per emissions permit or tax) below a certain ceiling price for cost containment to prevent a harsh impact on consumers and industry. Recent proposals for greenhouse gas regulation schemes in the USA, Australia and Japan support this assumption.

Given the assumptions outlined above, we calculate the potential annual demand for offset permits in Annex I countries based on the PACE model. Since some countries pledged a range of possible emissions reduction in their Copenhagen pledges, the demand for offset permits varies accordingly. Annual demand from the EU27, the USA, Canada, Japan, Australia and New Zealand will be 627 to 667 $MtCO_2e$ on average. To address the supply side, we calculate marginal abatement cost curves (MACs) for six regions of potential offset suppliers (Africa, Brazil/Mexico, China/India, South Korea/Indonesia/Malaysia, the rest of Latin America and the rest of Asia). The annual demand for offset permits of 667 $MtCO_2$ can be met at costs of about EUR 10 excluding transaction costs. The highest potential for offset generation stems from China and India followed by the rest of Asia. Latin America will be the smallest supplier, given that there is no scheme that allows for offset generation from REDD activities. Current offset schemes, i.e. the Clean Development Mechanism, will not be able to generate a sufficient amount of offsets to meet overall demand. Given that high potentials for offset generation are present in China and India, we conclude that alternative offset schemes like sectoral crediting, should be considered. Emissions reductions in smaller and less industrialised regions could be achieved by implementing a scheme of bi- or multilateral credited National Appropriate Mitigation Actions (NAMAs) in addition to the Clean Development Mechanism (CDM).

Das Wichtigste in Kürze

In den vergangenen Jahren konnten sich die Verhandlungsparteien der UN Klimarahmenkonvention (UNFCCC) nicht auf ein Nachfolgeabkommen für das Kyoto-Protokoll einigen. Die Verpflichtungsperiode des Kyoto-Protokolls endet im Jahr 2012. Ohne Nachfolgeabkommen gibt es weder eine Grundlage für bindende Emissionsreduktionen noch eine Grundlage für die Generierung von „offsets", also handelbaren Emissionsrechten aus Treibhausgasminderungen in weniger entwickelten Ländern und aufstrebenden Ökonomien. In diesem Aufsatz wird die mögliche Nachfrage nach und das möglich Angebot von Offset-Zertifikaten für die Zeit nach dem Kyoto-Protokoll (2012 bis 2020) analysiert. Zur Analyse bedarf es einiger Annahmen. So wird davon ausgegangen, dass Industriestaaten die Emissionsminderungsziele, die nach der Klimakonferenz in Kopenhagen vorgeschlagen wurden („Copenhagen Pledges") umsetzten. Dazu müssen heimische Systeme zur Treibhausgasregulierung eingesetzt werden. Dies können entweder mengenbasierte Regulierungssysteme sein, z.B. ein Emissionshandelssystem) oder preisbasierte Systeme wie eine Steuer. Voraussetzung ist jedoch, dass es einen internationalen Handel mit Emissionsrechten gibt, ähnlich wie er auch im Kyoto-Protokoll vorgesehen war. Zudem streben Industriestaaten eine Preiskontrolle in ihren Regulierungssystemen an, damit die heimischen Verbraucher und die heimische Industrie nicht übermäßig belastet werden. Gesetzesvorschläge aus den USA, Australien und Japan unterstützen diese These.

Gegeben der oben genannten Annahmen, ergibt sich eine Nachfrage nach Offset-Zertifikaten aus der EU27, den USA, Kanada, Japan, Australien und Neuseeland in Höhe von 627 bis 667 $MtCO_2e$ (durchschnittlich pro Jahr) abhängig von der genauen Umsetzung der „Copenhagen Pledges". Um auch die Angebotsseite zu beleuchten, werden Grenzvermeidungskostenkurven für Entwicklungsländer und aufstrebende Ökonomien errechnet. Es zeigt sich, dass die erwartete Nachfrage zu Kosten von rund EUR 10 pro tCO_2e erfüllt werden könnte, wobei Transaktionskosten unbeachtet bleiben. Der größte Teil der Emissionsminderungen könnte in China, Indien und dem restlichen Asien erbracht werden. Die geringste Menge käme aus Lateinamerika, wenn Offsets nicht in Waldprojekten generiert werden können. Sowohl Angebot und Nachfrage werden mit Hilfe des PACE-Models ermittelt. Es zeigt sich, dass gegenwärtige Offset-Mechanismen wie der Clean Development Mechanism (CDM) nicht geeignet sind, um Offsets in der oben genannten Größenordnung zu generieren. Daher wird vorgeschlagen vor allem in stärker industrialisierten Regionen wie China und Indien sektorale Ansätze zur Emissionsminderung anzustreben. Für andere Regionen mit einer weniger stark industriellen Prägung könnte das Instrument multi- oder bilateraler „credited National Appropriate Mitigation Actions (NAMAs)", also individuelle Emissionsminderungen in verschiedenen größeren Projekten zusätzlich zum CDM, sinnvoll sein.

A Practical Approach to Offset Permits in Post Kyoto Climate Policy

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Abstract

International Carbon Offsets from developing countries and emerging economies such as permits from the Clean Development Mechanism (CDM) will potentially play an important role for cost containment in domestic greenhouse gas regulation schemes in industrialised countries. We analyse the potential role of offset permits assuming that major emitters such as the USA, Canada, Japan, Australia and New Zealand install domestic greenhouse gas regulation schemes to achieve the emissions reductions pledged in the Copenhagen Accord and seek cost containment. We estimate a potential demand for offset permits of 627 to 667 $MtCO_2e$ p.a. from industrialised countries. To describe the supply structure, we derive marginal abatement cost curves for developing countries and emerging economies. We find that developing countries and emerging economies can supply 627 to 667 $MtCO_2e$ p.a. at costs of approximately EUR 10 (in 2004 EUR), neglecting transaction costs and country specific risks. The highest potentials for the generation of carbon offsets are present in China, India and the rest of Asia.

JEL-Classifications: Q52, Q58

Keywords: emissions trading, offsets, CDM, marginal abatement costs, climate policy

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1. Introduction

If major emitters of greenhouse gases (GHG) decide to adopt binding emissions reduction targets in an international agreement, appropriate domestic policy instruments for GHG mitigation to achieve the targeted amount of abatement are necessary. Carbon pricing is seen as the most efficient way to mitigate GHG. A price on carbon can, in general, be implemented by a tax on GHG emissions or via a cap and trade scheme that limits the annual amount of economy wide emissions and allows trading of emissions permits. From a political point of view, cap and trade schemes have several advantages compared to a tax, including the option of free allocation of permits and the guarantee that a certain abatement target can be reached (Keohane, 2009). Hence, it is likely that cap and trade schemes for GHG mitigation will evolve in a number of countries that commit to binding abatement targets. In that case, cost containment often plays an important role for policy makers to secure economic competitiveness and to avoid sudden negative impacts on consumers. One important option for cost containment in a cap and trade scheme is the import of additional emissions allowances from abroad. Under the Kyoto Protocol this is possible inter alia via the Clean Development Mechanism (CDM) where verified emissions reductions in developing countries (offsets) can be converted into emissions allowances that are eligible for compliance. Recent proposals for cap and trade schemes in the USA, Japan and Australia revealed that the use of international offset permits in domestic trading schemes is considered an important option for cost containment.

In this paper, we examine whether and how it would be possible to continue an offset-policy similar to that under the Kyoto Protocol in a post-Kyoto era when major developed countries (Annex I countries) install cap and trade schemes for GHG mitigation and seek for cost containment via the use of international offset permits from developing countries and emerging economies (Non-Annex I countries). To do so, we first discuss the recent developments in international climate policy and summarise existing GHG regulation for several countries. In section 3, we discuss possible developments in the post Kyoto era until 2020 and derive the possible demand for offset permits of major emitters such as the USA, Canada and Japan when they seek for cost containment to avoid a harsh negative economic impact of their respective domestic climate policy. Mitigation levels are based on the pledges made in the Copenhagen Accord in January 2010. In Section 4 and 5, we discuss the role of offset markets and derive marginal abatement cost curves for Non-Annex I regions based on the PACE (Policy Analysis based on Computable Equilibrium) model. We then compare the possible demand and supply structure and discuss the consequences of broad offset use.

2. An Overview of Existing GHG Regulation

Currently the only large-scale mandatory Emissions Trading Scheme for Greenhouse Gases (GHG) exists in the **European Union**. The EU Emissions Trading Scheme (EU ETS) regulates about 11,000 installations in 30 countries: the EU27, Norway, Iceland and Liechtenstein. From 2012 onwards aviation will be included in the EU-ETS. From 2013 onwards new activities (e.g. non-ferrous metals) will be included in the EU ETS which will add some 107 million tons of CO_2e per year to the scheme (EU, 2010). While the EU ETS only regulates CO_2 emissions in the years from 2005 to 2012, further Kyoto gases, namely N_2O and PFC will be covered post 2012. Currently at least 90 per cent of EU-Emission Allowances (EUA) have to be allocated for free by member states. From 2013 onwards electricity generating facilities will receive no more free allocation. Most other industrial sectors are expected to be exposed to the risk of carbon leakage and will receive free allocation depending on efficiency measured by efficiency benchmarks within the sector (see decision of the EU Commission 2010/2/EU). The ten per cent most efficient installations within one sector will receive 100 per cent free allocation. All other facilities receive allocation based on the performance of the ten per cent most efficient facilities. In practice, this means that most installations will receive far less free allocation from 2013 onwards. Free allocation shall be phased-out until 2027 (EU, 2009). Within the EU ETS the use of 1.6 to 1.9 billion offset-permits from the Clean Development Mechanism (CDM) and Joint Implementation (JI) will be eligible for compliance for covered installations within the 2008 to 2020 period. In addition to that, the use of 1.1 to 1.3 billion Certified Emission Reductions (CERs) is possible outside non-ETS sectors (Kossoy & Ambrosi, 2010; Barclays, 2010a; Baron et al, 2009). In 2008 to 2010, 277.3 million CERs and 24.4 million Emission Reduction Units (ERUs) where used for compliance in the EU ETS.

New Zealand introduced its trading scheme (NZ ETS) in July 2010. From 2010 to 2013 industrial and energy producing installations are covered by the scheme. Until 2013, each emitter has to surrender one permit for every two tons of emissions. From 2013 to 2015 further sectors like agriculture will enter the scheme. The scheme covers all six Kyoto gases. Until the end of 2012, New Zealand guarantees a price-ceiling for permits of NZD 25. The use of CERs, ERUs and Assigned Amount Units (AAUs) for compliance in the NZ ETS is allowed without quantitative restrictions.

Japan had pledged an emission reduction of 25 per cent compared to 1990 in the follow-up of the Copenhagen Accord. In 2010, the Democratic Party of Japan (DPJ) tried to push forward a proposal for a mandatory domestic emissions trading scheme in Japan. However, political opposition and critical comments from the Japanese industry hampered the introduction of the scheme. It is likely that, as a consequence of the dramatic earthquake in March 2011, Japan will postpone the introduction of the trading scheme for years. Japan already started to implement its own scheme to generate international offsets in bilateral cooperation with certain project host-countries. The Japanese government pledged USD 9.8 million to implement the offset-scheme. The start of the first projects was initially scheduled for spring 2011. Japan initially intended to generate up to 1.3 billion offset-permits in its bilateral scheme until 2013. The scheme would have operated clearly outside the CDM framework and without governance by the UNFCCC (Dow Jones, 2010). In Japan, a voluntary emission reduction scheme (JVETS) was introduced in 2005. Participating companies were asked to announce an individual amount of targeted emission reductions. Registered companies were able to apply for subsidies to achieve the emissions reduction. CERs and ERUs as well as demonstrated domestic emission-offsets are valid for compliance under the JVETS, meaning that emission reduction can also be achieved abroad or in other sectors in the Japanese economy. In December 2008, only 501 companies participated in the scheme and they covered only a small part of country-wide emissions. Hence, the JVETS only yields marginal emission reductions which are not sufficient for Japan to achieve its Kyoto commitment or any further emissions reduction target (Jones and Yoo, 2009). Tokyo introduced a municipal emission reduction scheme in the sense of a local emissions trading scheme. The Tokyo ETS includes 1,400 sources of GHG emissions including 300 industrial installations. Entities with more than 1.5 million litres use of crude oil equivalent are obligated under the scheme. The scheme started to operate on 1 April 2010. The 1,400 covered entities have annual emissions of about 13 million tons CO_2. Until 2015, an emissions reduction of 6 per cent is planned and in the second commitment period from 2015 to 2020 a reduction by 17 per cent is scheduled. The Tokyo ETS allows the use of domestically generated offsets while international offsets from CDM or JI are not eligible for compliance. The province of Saitama plans a scheme similar to that of Tokyo which is expected to start operating in April 2011 (TMG, 2010; World Bank, 2010).

In **Australia,** the plans of Prime Minister Kevin Rudd (Australian Labor Party) for a mandatory domestic emissions trading scheme (Carbon Pollution Reduction Scheme, CPRS) were postponed in December 2009. After national elections in 2010 the Labor party was re-elected tightly. Under the new Prime Minister Julia Gillard (Labor) the question of carbon pricing came back to the political agenda. After the failed efforts of Kevin Rudd to implement an ETS and because of massive lobbying against an ETS by mining companies, the political discussion in Australia points toward a GHG tax at the moment. A panel of experts was asked to lay out a plan for carbon pricing in Australia until December 2011. In addition to that, a review of the white paper on carbon pricing ("Garnaut Review") will be prepared. In February 2011, the Australian Government announced that a tax on heavy sources of GHG emissions shall be set until mid-2012. The tax is expected to be AUD 20 to 30. The tax scheme could probably be expanded to a permit based trading scheme in the future. Initially, a price-cap for phasing in the Australian ETS was planned. In the first two years of the scheme, prices would have been fixed at AUD 10 while permits would not have been bankable. In the following four year period, the price cap would have been AUD 40. After these four years, the price cap was intended to increase on an annual rate of five per cent (Betz and Owen, 2010). Since 2003, a mandatory baseline and credit scheme for GHG emissions from energy use – the Greenhouse Gas Reduction Scheme (GGAS) – has been active in New South Wales. The scheme was expanded to the Australian Capital Territory (ACT) in 2005. The goal was to cut back per capita emissions from 8.65 tCO_2e in 2003 to 7.27 tCO_2e in 2007. In order to reach the goal, domestic carbon-offsets projects can be carried out (IPART, 2010). However, since the GGAS is a regional scheme with a moderate emissions reduction target, it is not adequate to achieve larger overall emission reductions in Australia and cannot replace a mandatory national scheme for carbon pricing. In addition to that, Passey et al (2008) express doubt about the ecological effectiveness and economic efficiency of the GGAS.

In the **USA,** political efforts to implement a mandatory ETS failed twice in 2009 and 2010. In 2009, the American Clean Energy and Security Act (H.R. 2454), also called Waxman-Markey Bill, passed the House of Representatives but was rejected in the US Senate. In summer 2010, the "American Power Act" (APA) proposed by John Kerry and Joe Lieberman had no chance to pass legislation. Both proposals aimed to implement a US-wide ETS. Looking at the more recent proposal, the APA would have introduced a price cap of USD 25 in 2013 which would have risen annually by 5 per cent plus the inflation rate. In addition to the price cap, the use of a large number of offset permits would have been possible. In the APA, the emissions cap in 2013 would have been set at 4,722.0 Mt CO_2e. The use of 2,000 Mt in offset permits (500 Mt in international permits and 1,500 Mt in domestic offsets) per year would have been possible. The U.S. Environmental Protection Agency (EPA, 2010) estimated that under the APA an annual amount of averagely 161 Mt in offset permits would have been used for compliance until 2020. In the US, the **Regional Greenhouse Gas Initiative (RGGI)**, which was implemented in 2008, is currently the only operating mandatory regional trading scheme. The goal of the RGGI is to stabilise GHG emissions from electricity producing facilities at 170 $MtCO_2e$ per annum from 2009 to 2014. From 2014 to 2018, an annual decrease of the cap by 2.5 per cent is scheduled. CO_2 emissions from about 200 electricity producing installations with more than 25 MW output are regulated under the RGGI. Offset permits can be used for compliance up to 3.3 per cent of the absolute emissions level. Offsets have to be generated outside the electricity sector and within RGGI states or US states who signed a "Memorandum of Understanding" (MOU). If the price for RGGI permits exceeds USD 7 (on average over the previous 12 months), offsets can be used up to a limit of 5 per cent. If the price exceeds USD 10, the limit is further expanded to 10 per cent of emissions and international offset permits from the CDM or JI can be used for compliance. In addition to the RGGI, two other mandatory regional schemes are currently evolving in the US. The **Western Climate Initiative (WCI)** is a cooperation of seven US states and four Canadian provinces. The aim is to reduce GHG emissions by 15 per cent until 2020 compared to 2005 (WCI, 2010a). The WCI is expected to start in

2012. In the first commitment period from 2012 to 2014, large electricity producing installations with more than 25,000 tCO_2 emissions per annum will be covered. They account for about 50 per cent of GHG emissions within the region. Starting in 2015, the scope of the scheme will be expanded to other sectors such as industry or transport. The WCI would then cover about 90 per cent of GHG emissions within the region. To control costs in the WCI, the use of offset permits will be allowed up to a certain limit. A model based evaluation of the WCI implies that effective demand for offsets will add up to 235 Mt CO_2e from 2012 to 2020 (WCI, 2010b; WCI 2010c). In the **Midwest GHG Reduction Accord (MGGRA),** six US Midwestern states and one Canadian province aim to reduce GHG emissions by 15 to 20 per cent until 2020 and 60 to 80 per cent until 2050. Within the scheme about 20 per cent of emission reductions could be delivered through offset. The scheme does not yet operate and detailed regulation has to be laid out. The MGGRA scheme is expected to start in 2012. The three mandatory regional schemes in the US and Canada jointly account for some 2.5 billion t CO_2e which is approximately 37 per cent of the total GHG emissions in the US. In addition to the mandatory regional schemes, there are voluntary GHG emission reduction schemes and offset programs such as the Chicago Climate Exchange (CCX), the Climate Action Reserve (CAR), the Voluntary Carbon Standard (VCS), the American Carbon Registry (ACR) or the Alberta Offset Scheme in Canada.

In November 2009, US President Barack Obama declared GHGs as “dangerous gases” which makes it in principle possible for the US EPA to regulate GHG emissions under the Clean Air Act (CAA). After it became clear in August 2010 that the APA has no chance to pass legislation, the EPA began to prepare the regulation of large CO_2 emitting sources under the CAA. Starting in January 2011, installations that are already regulated under the CAA and emit more than 75,000 t CO_2e per annum shall be regulated. The regulation could be expanded later on to installations that emit more than 100,000 t CO_2e and are currently not included in CAA-regulation.

Concerning Climate Policy, **Canada** has a close orientation to the US. Right now, Canada has no plans to implement a carbon pricing scheme. However, Canada wishes to build a common regulation scheme with the US if the US decides to price carbon.

Russia, Ukraine or Kazakhstan seem to have no plans for carbon pricing. From the Kyoto Protocol, former members of the Soviet Union have a large surplus of Assigned Amount Units (AAUs) because of the post-soviet economic reconstruction in the 1990s. The large amount of surplus AAUs, also referred to as “hot air”, and moderate pledges to the Copenhagen Accord do not make carbon pricing necessary. In November 2010, **South Korea** announced plans to implement an emissions trading scheme in 2013. Currently more than 370 companies are asked to set individual energy-efficiency targets until September 2011. South Korea and Japan signalised in early 2010 that they wish to link their potential GHG trading schemes. **China** plans to install trial trading schemes for GHG emissions and energy-efficiency certificates. Regional trial schemes could start in 2012 in Beijing, Shanghai and eleven other regions. **India** also plans to install trading schemes in selected industrial areas. An emissions trading scheme is also discussed by the International Maritime Organization (IMO) for **international shipping**. Voluntary carbon markets currently account only for a small part of the world carbon markets.

Table 1: Overview of mandatory GHG regulation schemes

Region / Scheme	Covered Regions	State
Europe (EU-27) European Emission Trading Scheme (EU ETS)	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom	Mandatory Scheme Operating since 2005
Non-EU states (linked to EU ETS)	Norway, Iceland, Liechtenstein	Fully linked to EU ETS
Switzerland	Country-wide	Swiss ETS and CO_2 Tax (planned link to EU ETS)
New Zealand (NZ ETS)	Country-wide	Mandatory Scheme Operating since 2009
South Korea	Country-wide	Trial ETS since 2008 Mandatory ETS planned for 2013
Tokyo ETS	Municipal of Tokyo (Japan)	Mandatory regional ETS since 2010
Saitama ETS	Province of Saitama (Japan)	Mandatory regional ETS planned for 2011
RGGI (Regional Greenhouse Gas Initiative)	Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, Vermont, Massachusetts, Rhode Island, Maryland	Mandatory regional ETS since 2008
WCI (Western Climate Initiative)	Arizona (USA), California (USA), New Mexico (USA), Oregon (USA), Washington (USA), Utah (USA), Montana (USA), British Columbia (CDN), Manitoba (CDN), Ontario (CDN), Quebec (CDN)	Mandatory regional ETS, start expected for 2012
MGGRA (Midwest GHG Reduction Accord)	Iowa (USA), Illinois (USA), Kansas (USA), Manitoba (CDN), Michigan (USA), Minnesota (USA), Wisconsin (USA)	Mandatory regional ETS, start expected for 2012

Source: ZEW

Table 2: Emission reduction pledges of selected countries from the Copenhagen Accord

Country	Emissions Reduction Pledge (Reduction in 2020)	Base Year
Australia	5% / 15% / 25%	2000
Canada	17%	2005
EU	20% / 30%	1990
Japan	25%	1990
Kazakhstan	15%	1992
New Zealand	10% / 20%	1990
Russ. Federation	15% / 20%	1990
Ukraine	20 %	1990
USA	17 %	2005
Brazil*	36.1% - 38.9%	-
China*	40% - 45% per unit GDP	2005
India*	20% - 25% per unit GDP	2005

Source: UNFCCC (2010) http://unfccc.int/home/items/5262.php * Voluntary emission reduction (pledge not binding)

Table 3: Traded volumes (Mt CO_2e) 2009 by market segment

Market segment	Traded Volume (Mt CO_2e)	Market share
EU ETS	6,326	72.7 %
Spot & Secondary Kyoto offsets	1,055	12.1 %
Regional GHG Initiative (RGGI)	805	9.3 %
Primary CDM	211	2.4 %
Assigned Amount Units (AAUs)	155	1.8 %
Chicago Climate Exchange (CCX)	41	0.5 %
Other voluntary markets	46	0.5 %
New South Wales (NSW)	34	0.4 %
Joint Implementation (JI)	26	0.3 %
Total	**8,699**	**100.0 %**

Source: Kossoy & Ambrosi (2010)

Table 1 summarises operating and planned mandatory GHG trading schemes. Table 2 gives an overview over the emission reductions pledged by important Annex I and Non-Annex-I countries in the follow up to the Copenhagen Accord. Pledges were made in early 2010. Due to different base-years the amount of emission reductions cannot be compared easily between countries. Table 3 summarises the traded volumes on the world carbon market as presented by Kossoy and Ambrosi (2010). Currently the EU ETS dominates the world carbon market followed by secondary Kyoto Offsets. However, many secondary CERs are traded by companies regulated under the EU ETS. The RGGI as the first mandatory regional trading scheme in the USA only plays a minor role, the same applies to the NSW trading scheme in Australia. Bianco and Litz (2010) note that existing efforts in the USA including regional initiatives and regulation of large facilities under the Clean Air Act might not be appropriate to achieve an emissions reduction of 17 per cent in 2020 compared to 2005 as pledged by the USA. The US pledge clearly states that the pledge is dependent on the "anticipated U.S. energy and climate legislation, recognizing that the final target will be reported to the Secretariat in light of enacted legislation" (US Dep. of State, 2010). Thus, it becomes clear that the USA takes a "wait and see" position that effectively could hamper international negotiations under the UNFCCC and that on the flip-side a comprehensive national GHG policy is needed if the pledged emissions reduction shall be met. Since the APA failed to pass legislation in the summer of 2010 and the Democrats lost seats in the US Senate and the House of Representatives in the mid-term elections in November 2010, a new approach to implement a comprehensive GHG regulation in the USA cannot be expected before 2013. However, in section three we examine the possible shape and scope of a world carbon market that could evolve if major Annex I countries including the USA would choose a cap and trade approach to regulate GHG emissions. Thereby, we also focus on the need for price control within the possible future trading schemes and examine the role of the international offset markets.

3. Possible Development until 2020

While the discussion in section 2 above is a highly political one, it sets the framework for further discussion on the possible shape and scope of carbon markets that could evolve in the future. These markets basically evolve because of governmental regulation, in the case discussed here, the pricing of GHG emissions to mitigate climate change and, hence, to improve or preserve environmental quality (Stavins, 2011). It is important to note that the only existing national mandatory trading schemes for GHG mitigation exist in the EU, Norway, Liechtenstein, Iceland and New Zealand. Important emitters such as the USA, Canada, Japan or Australia have not yet introduced appropriate regulation to meet their emissions reduction targets pledged under the Copenhagen Accord. Other Non-Annex I countries such as Brazil, China, India or South Korea start to implement measures for GHG abatement but are unwilling to pledge binding emissions reduction targets. Now we develop a possible scenario for the future of the world carbon markets assuming that important Annex I countries introduce a GHG trading scheme. Non-Annex I countries are expected to be net-exporters of offset permits because of the voluntary nature of their pledged emissions reduction targets.

3.1 The Political Economy of GHG Regulation

Howe (1994) reviews the historical development of regulation in the USA and the EU. He points out that the US tends to apply quantity-based regulation (e.g. emissions trading) while regulation in the EU is dominated by regulation via prices (e.g. environmental taxes) or standards. With regard to GHG regulation this trend has stopped or maybe even reversed. Ellerman et al (2010) point out that the EU initially wanted to introduce a Europe-wide carbon tax and has been in opposition to carbon trading in the Kyoto negotiation process. However, a proposal for a community-wide carbon tax was withdrawn in 1997 and “eliminated” the political option of an EU-wide tax on GHG emissions. Pricing carbon under a commitment like the Kyoto Protocol comes along with some difficulties. Considering the academic debate on prices vs. quantities it follows Weitzman (1974) that GHGs can be efficiently regulated by posing a tax rather than controlling quantities. The reason is simply because the slope of marginal costs is expected to be steeper relative to the slope of marginal benefits in the long run. While climate change is a serious environmental problem, it does not appear all of a sudden when a critical amount of GHG emissions or a certain stock of GHGs is reached. Climate change occurs over a long period. Hence, a tax can be imposed on emissions and can be corrected over time so that the desired amount of emissions reduction is reached. Newell and Pizer (2003) find that price controls are more efficient than quantity controls in the case of GHGs. They state that under general conditions price instruments should be preferred when abatement rates are below 40 per cent. The authors conclude that this has important implications for the Kyoto Protocol which mandates an aggregated emissions reduction of five per cent by quantity controls. Nordhaus (2006) favours a price approach to cope with climate change. He summarises pro and contra arguments for an international agreement on prices rather than quantities. Mixed price and quantity policies were first proposed by Roberts and Spence (1976). Pizer (2002) argues that a mixed scheme of price and quantity controls for GHGs could significantly improve welfare when additional permits could be sold on the market if a certain "trigger-price" is reached. Price ceilings for emissions trading were inter alia discussed by Wood and Jotzo (2010), and are actively applied in the New Zealand ETS. They are also considered for possible schemes in the USA or Australia. If the price ceiling is reached, the quantity approach of emissions trading actually converts to a price control (tax). Now two questions arise: first, why do international agreements like the Kyoto Protocol mandate quantity restrictions rather than a more efficient price control? Second, does it make sense for countries under a quantity restriction to decide for price controls rather than implementing a cap and trade scheme? Here, price controls can mean a pure carbon tax as well as a binding ceiling price constraint within a cap and trade scheme.

The first question is, at first glance, answered easily: policy-makers prefer quantity commitments because they are transparent, easy to understand and to communicate and do not intervene directly into a country's fiscal policy. A price commitment would mean a much stronger commitment. Countries would be obligated to impose a tax within a certain timeframe because of the international agreement. In many cases this would simply not be politically feasible. A quantity target with international emissions trading leaves countries more political options and more time to decide for a certain policy. An international price approach would further require monitoring of fiscal policies. As Nordhaus (2006) states, this is a common and well known procedure with regard to international trade where the World Trade Organization (WTO) seeks to harmonise tariffs. However, implementing an international carbon tax could reduce the independence in fiscal policy of participating countries much more than harmonised tariffs. For example, certain subsidies (i.e. coal or fuel subsidies) must be prohibited if the carbon tax shall not be undermined. In addition to that, international trade yields immediate benefits for a country while benefits from GHG abatement and avoided climate change are much more uncertain and do not fully occur immediately. A complex political process like international negotiations on climate change needs clear cuts and easy messages. This is what Nordhaus (2006) called "focal" points. As he says, most people will agree that the world needs no AIDS, nuclear war or terrorist attacks that harm innocent people. Faced with the negative consequences of such problems the objective for policy-makers and the public becomes immediately clear: how to avoid them. With regard to climate change things are more complicated. The international community needed a relatively long time to establish a "focal point" for climate change – the two degree goal. While the two degree goal does not obviously make sense from a scientific point of view, it is an important contribution to rationalise the problem of climate change – a clear formulation of the problem. In the Copenhagen Accord the two degree goal serves as a somewhat "common vision" and helps to raise awareness of the public. Another issue that makes a price approach less attractive in international negotiations is the question of burden sharing. Shared burdens become clear when emissions reduction goals are negotiated. In contrast, by negotiating prices some countries would call for rebates so that burden sharing could be facilitated. Since a common uniform carbon price is the condition for equalising worldwide marginal abatement costs and, hence, for efficiency, burden sharing in an international price regime would require direct monetary transfers between countries. This again raises the question of efficiency in the allocation or use of the transferred money and the risk of corruption and abuse. After all, it appears that a price approach is second best in international negotiations from a political or practical point of view although it is first best in the economic sense. Probably the relative disadvantage of quantities compared to prices and the resulting welfare loss must be regarded as the "willingness to pay" for political feasibility and transparency of pledges in international negotiations.

Taking into account the preferences for quantity targets in international negotiations, the next question is what the best response to a quantity based commitment will be. In general, Annex I countries under the Kyoto-Protocol are free to choose any policy approach to reach their emissions reduction target. The range of actions is large. It ranges from the European example of imposing a cap and trade scheme to a carbon tax as in the case of Switzerland and to the large share of countries that take a wait-and-see position like Japan, which recently started buying large amounts of AAUs and offset permits to balance their emissions. The main question now is: does a price approach make sense from an economic point of view if a certain quantity of emissions must not be exceeded?

If there is certainty about marginal abatement costs, price and quantity approaches are identical. However, since marginal abatement costs are uncertain, applying a carbon tax will almost certainly not yield the targeted amount of abatement. If the tax is set too high abatement will be higher than necessary. In that case the country can sell its surplus AAUs, but the revenues will probably not fully compensate the country for the additional abatement efforts and dead weight losses generated from the carbon tax. Vice versa, if the tax is too low, the country abates too little to reach its individual target and AAUs have to be purchased on the market. If AAUs are available at low prices (i.e. because of "hot air") this could be a beneficial strategy from the countries' perspective. However, if AAUs are more expensive than domestic abatement, the tax leads to efficiency losses. Thus, posing a carbon tax under binding global emissions targets might in most cases be second best in terms of efficiency. In addition to that, the government bears the risk of buying additional permits on the expenses of the national budget when the tax is set too low. However, some countries seem to have preferences for fixed prices or low price volatility.

As a result of the economic crisis of 2008 and 2009 prices in the EU ETS are relatively low. Some argue that prices are too low to incentivise investment in green technology. Low prices in the EU ETS are the result of the drop in emissions during the economic crisis and a resulting surplus of allowances in the second trading period (Löschel et al, 2010). In this case, price volatility can effectively hamper green investment. While the quantity target can be reached because of the fixed amount of permits within the scheme, regulated companies are confronted with high uncertainty about future prices and might refrain from investment in energy efficiency because downward price volatility can result in sunk costs when the investment in green technology is not reversible. In this special case, a price floor that signals a certain future minimum price for allowances and that could be implemented at zero costs for the regulator could help to foster green investment if permits are bankable.

In most cases upward price volatility is seen as the more important problem. In the proposals for GHG emissions trading schemes in the US and Australia and in the New Zealand scheme, price ceilings and generous use of international and domestic offset permits are included to control costs. This seems to be one of the most important aspects of the proposed schemes from a political point of view. The reason is clearly that consumers and industry must be convinced that the negative economic impact of the GHG regulation is modest and that it will not result in a loss of competitiveness or a loss of jobs. Reading proposals for GHG trading schemes such as the American Power Act or the White Paper for the proposed Australian trading scheme from December 2008, protection for industry and consumers is the most important aspect. Here, protection means avoiding high carbon prices in the first place. Targeting prices and assuring that the emissions constraint within a cap and trade scheme is met can be facilitated by two measures. First, by imposing an emissions reserve as proposed in the APA: in this case, the regulator holds back allowances as a strategic reserve that can be sold on the market to bring down prices in certain situations. Second, by purchasing additional allowances such as AAUs or international and domestic offset permits: permits can be either bought by the government (like AAUs) to broaden the national emission budget or by regulated private entities (like offset-permits for compliance in a domestic trading scheme). The first option poses a risk to the national budget while the second option privatises the cost risks for meeting the price ceiling and might be, therefore, preferred by many policy-makers.

If we now turn to the discussion of the possible shape and scope of future GHG regulation in major Annex I countries, we do this in the light of two assumptions.

a) Preference for quantity regulation: quantity based approaches are expected to be preferred by policy-makers. This is because the global emissions constraint (i.e. from the Kyoto Protocol) can be reached almost certainly without posing a risk to the national budgets that could stem from necessary AAU purchases in the case of a tax that does not yield the targeted amount of abatement. Price control can be applied in a cap and trade scheme by generating a permit-reserve and/or allowing the use of domestic or international offset permits for compliance by private entities under a trading scheme. The use of offset permits by private entities effectively expands the allowed overall emissions level of a certain country and, hence, relaxes the real emissions cap compared to the nominal emissions cap. In this paper, we regard the pledges made in the Copenhagen Accord as the nominal emissions cap of Annex I countries where Q expresses the respective absolute emissions quantities.

$$Q_{real} = Q_{nominal} + Q_{offsets}$$

Since prices depend on the available emissions permits under a cap and trade scheme $P_P(Q)$ and $dP/dQ<0$, prices drop when the amount of available permits is expanded and $P_P(Q_{real}) < P_P(Q_{nominal})$.

The preference of policy-makers for quantity-based regulation can partly be explained in the framework of Weitzman (1974). While climate change occurs gradually in the long run, policy-makers have a particularly short planning horizon, i.e. the election period. In certain cases the slope of the marginal benefits curve from climate change counter measures might then be perceived as steeper than marginal costs where targeted amounts of emissions are exceeded and national budgets are exposed to the risks of additional permit purchases. Additional incentives to choose a quantity approach rather than a price approach stem from higher flexibility for policy-makers under a quantity approach, i.e. through grandfathering of allowances (Keohane, 2009).

b) Price control and price targeting: countries seek to control prices for GHG emissions, especially when the regulation is phased in. Price control is an important aspect for political feasibility of GHG regulation because consumers and industry must be convinced that the regulation has a minor impact on their income, on job security or international competitiveness. This assumption is reasonable when looking at recent proposals for GHG regulation in the USA, Australia or New Zealand. Here, price control occurs in the form of price ceilings that are applied within a cap and trade approach for GHG. When designing GHG regulation, countries are expected to target prices so that prices within the domestic scheme are similar or at least not significantly higher than expected prices in other schemes for GHG regulation. This is because permit prices can be an important determinant for competitiveness among Annex I countries. Here we also assume that no direct links between the trading schemes of Annex I countries are established. This is because linking would imply an import of stringency from one to the other schemes. Some countries such as the USA fear rising carbon prices as a consequence of linking to more stringent schemes as it would be the case in Japan or Canada. While other regions such as the EU have an aversion against linking because they fear that the stringency of their own rules and procedures could be undermined, e.g. if the limit for offset-use is less strict in a linked scheme, the EU will effectively import the laxer rules because of possible permit imports from the linked scheme (Jaffe and Stavins, 2010). Also future changes, such as the adoption of the 30 per cent emissions target by the EU, could have an effect on the stringency of a linked scheme. If carbon prices in the EU rose, prices in the linked scheme would rise. This is why most countries currently do not seek linking. Targeting prices effectively is a special case of linking emissions trading schemes while avoiding possible side-effects of decisions in other countries with GHG regulation. Price targeting allows for an at least approximate harmonisation of prices between the trading schemes, but leaves one certain scheme unaffected by changes in other trading schemes.

Price targeting occurs if a domestic emissions trading scheme is designed so that prices are equal or approximately equal to the expected prices in other trading schemes (rest of the world, ROW):

$$P(Q_{real})_{dom} = E[P(Q_{real})_{ROW}]$$

The assumption of targeting leads to a situation in which countries choose the amount of eligible offset permits in their domestic trading schemes according to expected prices in ROW given the expected amount of eligible offset permits in ROW and given the ex-ante known nominal emission cap of both parties (domestic and ROW).

$$P(Q_{nominal} + Q_{offsets})_{dom} = E[P(Q_{nominal} + Q_{offsets})_{ROW}]$$

3.2 Possible Market Shape until 2020

In this section we examine a situation in which major industrialised countries such as the USA, Canada, Australia, New Zealand and Japan install emissions trading schemes, seek price control and target similar prices. In doing so, we focus on the demand and supply structure that evolves on the market for offset permits. Offset permits are expected to be used to enforce moderate prices within the domestic schemes. The aim of this paper is not to predict any specific future regulation, but to discuss the consequences of broad use of offset markets by large emitters when a cap and trade approach is chosen to regulate GHG emissions. When referring to offset schemes, existing schemes like the CDM or JI are addressed. However, since there are efforts to build new offset schemes beyond the CDM and JI and partly without governance by the UNFCCC the discussion is by no means limited to the existing schemes[1]. First, we collect information about existing and proposed regulation to draw a scenario of regulation under cap and trade schemes in certain industrialised countries. Then, the possible demand for international offset permits is derived under the assumption of price targeting. To evaluate the demand for offset permits the computable general equilibrium (CGE) model PACE is used (cf. Böhringer et al. 2009). To contrast the results, we calculate marginal abatement cost curves for industry and agriculture for six Non-Annex I regions (Africa, Brazil and Mexico, India and China, South Korea, Indonesia and Malaysia, the rest of Latin America and the rest of Asia).

PACE is a multi-sectoral, multi-regional computable general equilibrium model of international trade and global energy use. The model version used for the present analysis contains twelve regions and 24 sectors with a special focus on energy-intensive industries which are covered by the EU ETS. Potential emissions reductions in the different regions are introduced via an additional constraint that sets an upper limit to greenhouse gas emissions (in the current examination we investigate ceilings to CO_2 emissions only). The model solution connects a positive shadow price to the respective emission constraint which can be interpreted as the marginal abatement costs for the given reduction. In this manner, we can develop macroeconomic marginal abatement cost curves for the different model regions. A more detailed model description as well as a summary over the model regions and sectors is provided in the appendix. When comparing costs of domestic abatement in industrialised countries it is important to keep in mind that costs depend on the economic structure (i.e. state of efficiency in energy use and used technology) as well as on the amount of targeted abatement. In our analyses, we compare six industrialised countries (USA, Canada, the EU, Australia, New Zealand and Japan) based on their pledges made in the follow-up to the Copenhagen Accord (see Table 4). Australia and New Zealand are pooled to one region for the analysis.

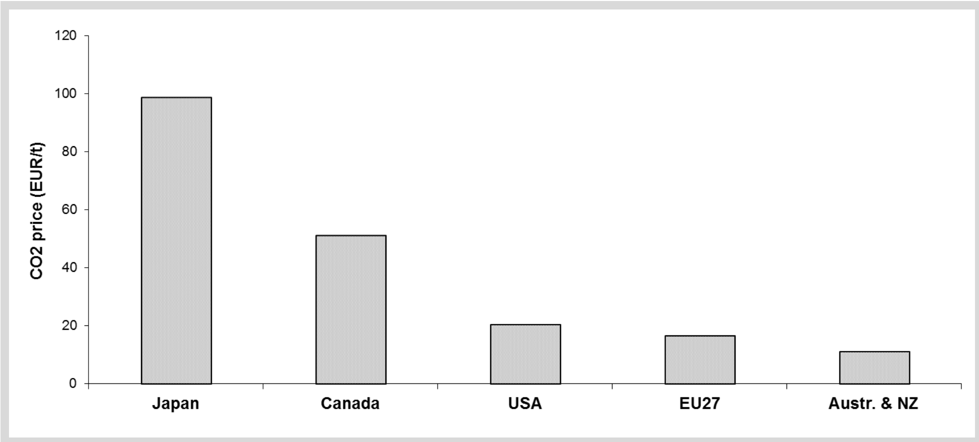
Table 4: Pledges of the major developed countries (Copenhagen Accord)

Country	Nominal Pledges		Harmonised Pledges % reduction based on 1990 Not including land-use change	
	Low (base year)	high (base year)	low	high
EU-27	20 % (1990)	30 % (1990)	20.00 %	30.00 %
USA	17 % (2005)	17 % (2005)	3.86 %	3.86 %
Canada	17 % (2005)	17 % (2005)	- 2.93 %	- 2.93%
Australia	5 % (2000)	25 % (2000)	- 13.00 % (pooled)	11.00 % (pooled)
New Zealand	10 % (1990)	20 % (1990)		
Japan	25 % (1990)	25 % (1990)	25.00 %	25.00 %

Source: UNFCCC, 2010 (http://unfccc.int/home/items/5264.php)

[1] Japan announced plans for a unilateral offset scheme in August 2010. Regional trading schemes in the USA seek to import offsets from certain projects in Latin America. In the future, apart from project-based offset generation other mechanisms such as sector-specific offsets in bilateral cooperation are discussed. Depending on the outcome of international negotiations REDD could probably be an important source for offset permits in the future.

Before we examine the possible size of capped emissions in the relevant regions, we calculate with the help of the PACE model the implicit carbon price in the six countries (five regions) that would occur when international offset permits would not be eligible for compliance within the GHG regulation schemes, implying that pledged emission reductions have to be carried out purely domestically. For the EU, the actual policy is implemented, i.e. the calculated costs for this region reflect the CO_2 price of the sectors subject to the EU ETS.



Graph 1: Costs of implementing the (low) pledges made in the Copenhagen Accord when international offset permits are not eligible for compliance under domestic GHG regulation. Prices in 2004 EUR per ton CO_2e for the year 2020 (Source: ZEW)

Graph 1 summarises the implicit permit price in the five developed model regions when the lower end of the abatement pledged in the Copenhagen Accord is achieved by pure domestic abatement. While costs are modest in the EU27, the USA and the Australia/New Zealand region, costs are relatively high for Japan and Canada. Thus, it becomes clear that if Japan and Canada aim to target a similar price than in the EU27, the USA and the Australia/New Zealand region, the use of domestic and international offset permits is a necessary component of any GHG regulation.[2]

We now examine the potential volume of cap and trade schemes in the five regions under consideration. While the EU-27 already has laid out the planned offset cap until 2020 other countries have not yet defined offset caps. For the USA the proposed scope of the trading scheme considered in the APA is chosen. Since Canada eyes to implement a joint GHG regulation with the USA, the APA proposal is

[2] Since the full extent of designs of possible emissions trading systems is not yet known, the costs in Graph 1 are calculated under the assumption that the trading scheme is applied to all sectors (industry, agriculture, services) of the economy, except for the EU. The regulation design might yield different prices if, for instance, only industrial sectors were covered by an ETS. As it is not clear which design might eventually be implemented in the different regions, we decided to use the actual policy design for the EU and a uniform carbon price for all economic sectors in the other regions.

also expanded to Canada. Australia and New Zealand are expected to choose upstream regulation that covers a large share of national GHGs. For Japan it is also assumed that upstream regulation is applied which covers not only industry and energy production but also supply of fossil energy sources. For all countries GHG emissions from land-use, land-use change and forestry (LULUCF) are not considered. This has implications in particular for Australia where LULUCF is relatively important. As a consequence the calculated demand for offset permits from Australia in PACE differs from the results presented by the Australian Treasury (2008). They expect that Australia will purchase 46 $MtCO_2e$ (low) to 112 $MtCO_2e$ (high) p.a. Emissions data is obtained from the Climate Analysis Indicators Tool (CAIT) of the World Resources Institute in Washington (WRI, 2010).

Table 5: Theoretical emission caps derived from the Copenhagen pledges

Region	**Emissions** **$MtCO_2e$** Source: WRI, 2010a	**Base Year**	**Possible cap** **$MtCO_2e$ (2013)**	**Possible cap** **$MtCO_2e$ (2020)**	**Offset-use** **Mio. permits** **(average per year)**
EU27	5,552.2	1990	A) 1,926.9	1,679.3	B) Up to 146
USA	6,948.2	2005	C) 4,722.0	5,095.0	D) 161
Canada	808.2	2005	549.3	592.6	E) 20
Japan	1,224.5	1990	F) 1,146.3	642.9	* 300
Australia #	513.4	2000	G) 381.3	362.2	** 0 [46] (low)
New Zealand	61.1	1990	H) Price cap 25 NZ$	41.2	** 40 [112] (high)
Total	**15,107.6**	-	**8,725.8**	**8,413.2**	**627 [673]# (low)** **667 [739] #(high)**

* Model result for Japan when a permit price of about EUR 20 is targeted (prices in EUR, year 2004)
** Model result for Australia and New Zealand. If the low pledges are implemented the price cap is not a binding constraint and the demand for international permits equals zero. If the high pledges are implemented the price cap becomes a binding constraint and demand equals 40 million international offset permits per year.
# The Australian Treasury expects that Australia will potentially be purchaser of 46 to 112 $MtCO_2e$ p.a. (Australian Treasury, 2008)
A) Decision 2010/384/EU of the European Commission
B) Communication of the EU MEMO/08/796 on the base of the 20 % reduction target and without new ETS sectors
C) Cap as defined by the American Power Act. Higher Cap in 2020 results from the inclusion of additional sectors after 2015
D) Offset-use as expected by EPA in their comprehensive analysis of the APA (see: EPA, 2010)
E) Figures for Canada derived from the assumption that Canada will mimic US regulation and possibly linking their regulation to the US.
F) Cap expected to cover approximately 80 per cent of total national emissions as in the case of an upstream cap and trade regulation. All industrial emissions (without agriculture) and emissions from power generation are included.
G) Cap under the assumption of an upstream cap and trade scheme (without agriculture) as proposed in 2008
H) Currently there is no cap in NZ but a price cap on emission permits. Figure for 2020 are derived from the assumption that the future cap will be set to meet the NZ-pledge made in the Copenhagen Accord by broad upstream regulation.

Source: ZEW

Based on the theoretical emissions caps that would result from the Copenhagen pledges and which are laid out in Table 5, we calculate the necessary amount of offset permits that has to be used to achieve a "moderate", harmonised average price of about EUR 20 (in 2004 EUR) per metric ton CO_2e emissions in the eight year period under consideration.

$$P(Q_{nominal} + Q_{offsets})_{dom} = E[P(Q_{nominal} + Q_{offsets})_{ROW}] = EUR\ 20$$

The targeted price of EUR 20 was chosen for the analysis because it matches the price ceiling proposed under the APA, the NZ ETS and the lower end of expected prices in the EU ETS. For the latter, expected prices vary in a range of EUR 21 to 28.10 for the period from 2013 to 2020 (Löschel et al.,

2010) or EUR22.10 to 25.40 (Löschel and Heindl, 2011). While expected volumes of used offset permits are known for the EU, the USA and Canada, we use the PACE model to calculate the necessary amount of offset permits for Australia, New Zealand and Japan if these countries try to avoid high permit prices and target similar prices as in the EU or the US.

Australia and New Zealand: The model results imply that the demand for offset permits from Australia and New Zealand will be zero when these countries implement their low pledges. In that case the permit price will not exceed the limit of EUR 20 in both schemes, the price cap is not a binding constraint and no additional permit purchases are necessary. If both countries implement their high pledges the price cap becomes a binding constraint and 40 million offset permits p.a. have to be imported.

Japan: As shown in Graph 1, Japan has relatively high domestic abatement costs given its pledge of a GHG reduction by 25 per cent until 2020 compared to 1990. Thus, international offset permits must be used generously to bring prices down to the assumed targeted price of about EUR 20 on average between 2013 and 2020. To do so, Japan would have to import an amount of 300 million international permits per year. At first glance it might be surprising that Japan would have to use a higher amount of international offsets than the US. However, considering the relative high pledge of Japan, the relative high domestic abatement costs and low availability of domestic offsets, high demand from Japan is a natural consequence. The result also helps to explain why Japan began to prepare for bilateral offset generation outside the UNFCCC framework in August 2010.

Summarising the results from Table 5, it is worth to note that the world carbon market would grow strongly if countries such as the USA, Canada, Australia and Japan introduced cap and trade schemes. The amount of capped emissions in 2020 would then be five times the volume of the EU ETS. As a consequence the demand for offset permits would also grow rapidly. While demand for offset permits from the EU ETS in the period from 2013 to 2020 is expected to be 146 million permits on average per year, the demand could increase up to 667 million permits if the USA, Canada, Australia and Japan introduced cap and trade schemes and targeted similar prices of about EUR 20 on average over the eight year period considered. As a consequence, the demand for permits would also be nearly five times the current demand that stems mostly from the EU ETS.

A survey among carbon market intermediaries and CDM project developers showed that the expectations in early 2011 according to the possible future demand for offset permits in a situation where all major Annex I countries install emissions trading schemes is similar to the results shown in Table 5. The survey participants expect the possible annual demand in such a situation to be 200 million offset permits in median for the USA, 77.5 million permits from Japan, 50 million from Australia and

New Zealand. In addition to that a demand for 20 million offset permits per annum could stem from voluntary carbon markets (Löschel and Heindl, 2011). While the overall sum of possible demand is similar to the results presented in Table 5, the survey participants have different expectations regarding the demand from Japan and the USA compared to the model results presented above. This could be inter alia because of the nature of the pledges made in Copenhagen. The emissions reduction target of Japan is much more stringent than that of the USA. In addition to that the Japanese economy is already relatively efficient in the use of energy, resulting in relatively high abatement costs compared to the USA.

4. The Role of Offset Markets

If offset permits from emissions reductions in Non-Annex I countries are considered as an important factor for cost containment in future emissions trading schemes, the question whether offset markets are capable to deliver the necessary amount of permits is a natural consequence. The CDM lags behind expectations in many aspects. Because of its nature as a project-based mechanism it only allows for certain projects. Large-scale emission reductions that cover whole branches of industries and that are known as “sectoral approaches” cannot be facilitated through the CDM. Small-scale projects such as the replacement of conventional light-bulbs by energy efficient ones face problems because of high fixed costs for implementing CDM projects and must be carried out under high risks within so-called Programs of Activities (PoAs). In general high transaction costs and long periods of project evaluation hamper investment in the CDM. In addition to that, the CDM Executive Board (EB), which evaluates the projects, is seen as a bottleneck that is responsible for many unnecessary delays in permit issuance. To make the story brief, many participants in the market are unsatisfied with the governance of the CDM. On the other hand, the EB has to make sure that emissions reductions under the CDM are additional, verified and persistent. These principles are the most important aspects of any offset scheme combined with measures that guarantee that the offset scheme does not provide perverse incentives. These incentives include, for instance, artificial expansion of emissions to generate a higher amount of permits under the scheme and harmful carbon leakage from one activity where emissions are reduced to another branch of the economy where additional emissions arise because of the offset scheme. Projections expect that the overall issuance of Certified Emissions Reductions (CERs) from the CDM from 2008 to 2012 will be about 940 to 950 Mt of CERs until the end of 2012 (Barclays, 2010b, 2011). Thus, the CDM alone seems not to be capable to deliver a large amount of offset permits unless it will be reformed. Hence, the Japanese government aims to install its own offset scheme to supply offset permits to a potential Japanese ETS. Similar plans were laid out in the APA where an independent US offset scheme was planned to generate domestic and international offsets.

While the structure of the future offset schemes is highly important for their economic efficiency and ecological effectiveness, we now turn to the question if the possible demand for offsets from future cap and trade schemes in Annex I countries can be met by Non-Annex I countries. To do so, we first look at the projected business as usual (BAU) emissions from Non-Annex I regions until 2020. Table 6 summarises the projections.

Table 6: Projected BAU emissions of CO_2 for Non-Annex I countries in 2020

Region	Projected emissions in 2020 (Mt CO_2, BAU)
Africa	1,698
Brazil and Mexico	1,139
China and India	11,244
South Korea, Indonesia and Malaysia	1,689
Rest of Latin America	763
Rest of Asia	4,052
Total	**20,585**

Source: International Energy Outlook 2008, Energy Information Administration des U.S. Department of Energy and own calculations (excluding land-use change)

If the USA, Canada, Australia and Japan introduced cap and trade schemes in 2013 and Australia and New Zealand implemented their high pledges, the demand for offset permits per year could sum up to 667 million tCO_2e. Within the eight year period from 2013 to 2020 total demand would be 5,336 million tons of offsets. The annual demand of 667 million tCO_2e is 3.2 per cent of projected BAU CO_2 emissions in 2020 for Non-Annex I regions. Given that the CDM currently delivers roughly 200 $MtCO_2e$ p.a. (Barclays, 2011, UNEP/RISOE, 2011) it becomes clear that the CDM in its current institutional setup can most likely not satisfy the possible future demand. This also explains why Japan and the US considered installing own offset schemes outside the CDM framework[3]. In general, it is questionable if the large amount of more than 5 billion tons of offsets could be generated in a timely manner while at the same time important principles like additionality or persistence of offsets is guaranteed. If there are a number of independent offset schemes in the future, the risk of double counting of emissions reductions must be addressed to prevent fraud. Thus, potential newly installed national offset authorities must link their registries and mutually check registered projects. Even if the offset schemes are well-designed in order to guarantee additionality and persistence of offsets, it

[3] In the American Power Act (APA), an own US-offset scheme would have been installed under the governance of the Environmental Protection Agency (EPA) to issue offset permits from domestic and international projects for GHG mitigation.

is likely that there will be an excess demand for offset permits. First, because there is a time lag between the start of an offset project and permit issuance and, second, because feasible offset projects and procedures must be developed by the market. The first problem can be solved partly if offset schemes are installed in advance of GHG regulation programs. The second problem is by no means trivial. Existing procedures like project-based offsetting might not be appropriate to deliver a large amount of permits in reasonable time. Hence, if offset permits play an important role for cost containment in Annex I countries it can be expected that alternative approaches to generate offsets, such as sectoral agreements, credited NAMAs or a broader and faster inclusion of REDD (Reducing Emissions from Deforestation and Degradation) in the carbon market is of interest for certain countries. While REDD has a high potential for GHG mitigation at relatively low prices, the broad inclusion of REDD in the carbon market is seen as problematic (Sohngen & Mendelsohn 2007).

5. Existing Abatement Options and Abatement Costs in Non-Annex I Regions

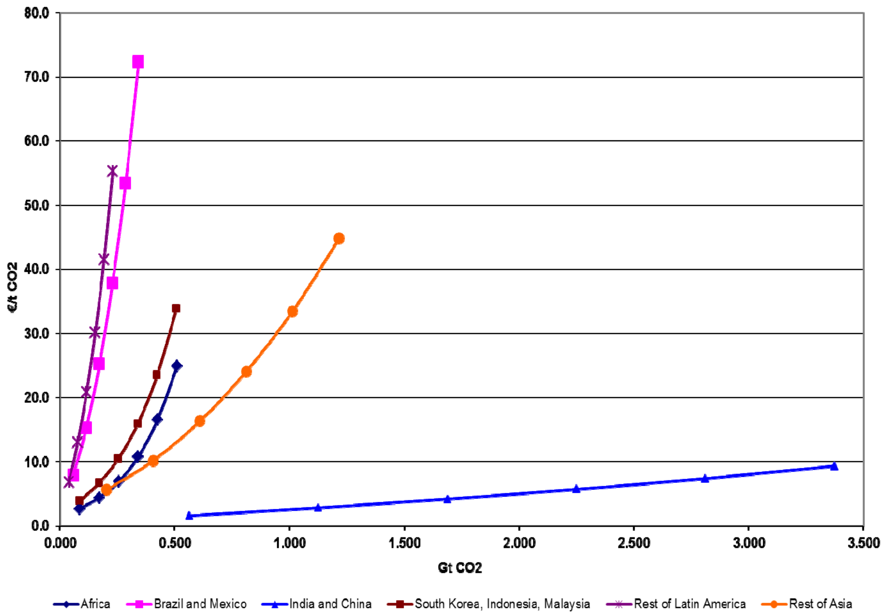
We now turn to the evaluation of existing options and costs for CO_2 abatement in Non-Annex I regions. The analysis is based on calculations derived from the PACE model. The regions under consideration are Africa, Brazil and Mexico, India and China, South Korea, Indonesia and Malaysia, the rest of Latin America and the rest of Asia. As summarised in Table 6, BAU emissions of CO_2 are projected to increase up to 20,585 $MtCO_2e$ per year by 2020.

Table 7 and Graph 2 summarise the model-based abatement costs that are evaluated in a range of 5 per cent to 30 per cent reductions for the selected regions. The calculated abatement costs do not include any transaction costs that arise when emissions reductions are made tradable through project-based or other activities (e.g. in the CDM, see Michaelowa and Jotzo, 2005). Furthermore, in the PACE model, CDM is expressed in a macroeconomic manner, i.e. the model does not include any projects. Instead, it computes overall emission targets for the economy as a whole. Transaction costs occur in project-based emission reduction projects because of costs for monitoring, verification and reporting of project activities. In addition to that, project-based emission reductions incur the risk that reduced emissions will not or only partly be issued with tradable permits. Activities in different regions also pose different country specific risks on project developers. Here, regional governance structures, existing infrastructure, corruption or experience of local DOEs and other officials with CDM projects can influence costs (Böhringer & Löschel, 2008).

Table 7: Marginal abatement costs for selected Non-Annex I regions (without REDD / LULUCF, without transaction costs, in 2004 EUR)

% of emission reduction (Reference: projection BAU 2020)		**5 %**	**10 %**	**15 %**	**20 %**	**25 %**	**30 %**
Africa	**Reduction (Gt)**	0.085	0.170	0.255	0.340	0.425	0.509
	Price EUR/t CO_2	2.7	4.4	6.9	10.8	16.6	24.9
Brazil and Mexico	**Reduction (Gt)**	0.057	0.114	0.171	0.228	0.285	0.342
	Price EUR/t CO_2	7.9	15.3	25.2	37.9	53.4	72.3
China and India	**Reduction (Gt)**	0.562	1.124	1.687	2.249	2.811	3.373
	Price EUR/t CO_2	1.6	2.8	4.2	5.7	7.4	9.3
South Korea, Indonesia and Malaysia	**Reduction (Gt)**	0.084	0.169	0.253	0.338	0.422	0.507
	Price EUR/t CO_2	3.9	6.7	10.5	15.9	23.5	33.9
Rest of Latin America	**Reduction (Gt)**	0.038	0.076	0.114	0.153	0.191	0.229
	Price EUR/t CO_2	6.8	13.1	20.8	30.1	41.5	55.4
Rest von Asia	**Reduction (Gt)**	0.203	0.405	0.608	0.810	1.013	1.216
	Price EUR/t CO_2	5.6	10.2	16.3	24.1	33.5	44.8
Non-Annex I Regions (aggregated)	**Reduction (Gt)**	1.029	2.059	3.088	4.117	5.146	6.176
	Price EUR/t CO_2	2.3	3.8	5.4	7.3	9.7	12.7

Source: ZEW



Graph 2: Marginal abatement cost curves in 2004 EUR for Non-Annex I regions (Source: ZEW)

Abatement costs are relatively moderate in Africa and the rest of Asia. However, abatement costs are the lowest in China and India and those regions by far have the highest potential amount for CO_2 abatement in the industry, energy generation and agriculture. It is important to note that REDD activities are not included in the calculation based on the PACE model. This explains why abatement costs are relatively high in Latin America. Actually REDD activities in Latin America have a high potential for offset generation at low costs. Graph 2 shows the dominance of Asia in the potentials for offset generation in a very impressive way. At a price of about EUR 10 China and India can jointly abate about 3,373 Gt of CO_2, or 30 per cent of projected BAU emissions in 2020. This is three times more than what all remaining regions under consideration can deliver jointly at a price of about EUR 10. This massive dominance of China and India is in line with the current situation in the CDM, where the largest share of issued CERs stems from China and India. With regard to REDD activities, analyses conducted by the EPA (2010) and model work by Sohngen and Mendelsohn (2007) show that REDD has large potentials for emissions reductions. Table 8 summarises the results.

Table 8: Costs for emissions reductions (Mt CO_2) by REDD activities. Time: 2010 (without transaction costs)

	1 USD	5 USD	15 USD	30 USD
Avoided Deforestation	17.6	1,144.2	4,262.7	6,402.6
Reforestation	5.7	24.1	627.6	1,499.8
Forest Management	250.9	207.3	259.6	243.1
Total	274.2	1,375.6	5,149.8	8,145.5

Source: EPA (2010) / Sohngen & Mendelsohn (2007)

Comparisons of the potentials of REDD based on the analysis of Sohngen and Mendelsohn (2007) and the potentials of abatement in industry, energy generation and agriculture derived from the PACE model are not directly possible because the calculations are based on different currencies. Assuming an exchange rate of 0.7618 USD/EUR as of 22nd December 2010, USD 5 yield EUR 3.809. While REDD can deliver 1,376 $MtCO_2e$ emissions reductions at this price, the corresponding emissions reduction of CO_2 from industry, energy generation and agriculture as derived from the PACE model sum up to about 2,059 $MtCO_2e$. Hence, industry, energy generation and agriculture are an important source of CO_2 emissions, but the potentials of REDD are considerable, especially in Latin America, some parts of Africa and South East Asia (Kindermann et al., 2008).

Now a few questions arise given the potential demand for offset permits, the existing abatement potentials in Non-Annex I countries and the existing organisational structure of offsets schemes. First, can the possible demand from Annex I countries be met by sufficient supply from Non-Annex countries at a certain price without using credited REDD? Second, is the existing framework for offset generation, namely the CDM, sufficient to facilitate the potential supply? Third, can offset markets lead to a kind of clean development as intended and postulated by the CDM?

If Annex I countries introduce trading schemes and target a price of about 20 EUR for phasing in their schemes, then it should be possible to reduce CO_2 emissions in Non-Annex regions by an amount of up to 30 per cent until 2020 compared to the BAU. This would lead to an amount of CO_2 emissions reduction based on BAU of 6.176 tCO_2e at a price of EUR 12.7 without transaction costs and not adjusted for country specific risks. While the expected demand for offsets could sum up to 667 million tCO_2e per year if the USA, Canada, Japan and Australia introduce emission trading schemes, the calculated amount of possible emissions reductions in Non-Annex I countries is based on the whole period between 2013 and 2020. Summing up the potential demand for the eight years under consideration (theoretically 2013 to 2020) leads to a total demand of 5.336 $MtCO_2e$. Thus, in theory the expected demand could be met by a calculated possible offset supply from agriculture and industry at a price below EUR 12.7 neglecting transaction costs and other organisational costs.

This leads directly to the second question mentioned above. Is the CDM able to facilitate such a high amount of supply of offset permits? The answer is no. Looking at the amount of permits issued in recent years it becomes clear that the CDM must be reformed in terms of its organisational structure if issuance should be sped up while additionality and permanence of emissions reductions is guaranteed. Moreover, the CDM is a purely project-based mechanism and project types are restricted to few technological options because of the lack of feasible methodologies in many sectors. A broader scope of emissions reductions could be achieved via sectoral agreements where offset permits can be issued when emissions are reduced under a certain baseline by a certain industry or sector. Sectoral offset schemes have higher requirements with regard to the organisational structure in the host country compared to project-based offset schemes (Sterk and Wittneben, 2006; Meckling and Gu Yoon, 2009; Sawa, 2010). While monitoring, reporting and verification (MRV) in project-based activities is not entirely scheduled within the host countries and monitored by an external body (i.e. the CDM executive board), MRV activities in sectoral agreements must be carried out by host countries or by bilateral cooperation in the first place (i.e. via a domestic emissions trading scheme for offset generation). Hence, sectoral agreements pose a higher degree of organisational complexity to the host countries. While China recently began to install emissions trading schemes for generating offsets in several cities and provinces that could serve as an organisational body for sectoral agreements in the future, such schemes might not be possible in many developing or least developed countries.

Addressing the third question whether the CDM is really a mechanism for clean development we would like to point out that the CDM does not assist economic development but does assist the structural change of developed economies toward a less GHG intensive economy. Apparently this has different implications for countries with a different state of economic development. In absolute numbers China and India can profit to the highest extent from offset schemes like the CDM. This is obvious because of the high amount of BAU emissions that stem from those countries. Less developed countries on the other hand are unable to profit from the CDM in its current state since it does not properly assist green development but assists the “greening” of existing economic structures.

6. Conclusion

If major Annex I countries introduced cap and trade schemes to regulate greenhouse gases and allowed the use of international offset permits for cost containment, the demand for offset permits would rise dramatically compared to the current situation. Due to relatively high costs for greenhouse gas mitigation, the USA, Canada and Japan would heavily rely on the use of international permits for cost containment. By computing marginal abatement costs for Annex I countries based on the Copenhagen pledges in the PACE model and assuming that Annex I countries seek to harmonise permit prices (targeting at roughly EUR 20 assumed) we conclude that the demand for offset permits could rise up to 667 Mt CO_2e per year on average in the first eight years after domestic trading schemes in Annex I countries are installed (see also Table 5).

Marginal abatement costs curves for Non-Annex I countries were derived from the PACE model to examine the capability of different Non-Annex I regions to supply the potential amount of required offset permits. The model results show that the potential demand from Annex I countries can be met at net prices for offset permits (without transaction costs) of less than EUR 12.7 per t CO_2e. Hence, international trading of offset permits could in theory be used as an instrument for cost containment by Annex I countries and could effectively assist Non-Annex I countries to reduce greenhouse gas emissions.

However, existing offset schemes like the CDM seem not to be capable to manage the generation of a larger amount of permits within a short period of time. In addition to that, the CDM assists the "greening" of existing economic structures rather than the development of economic structures in a greenhouse gas extensive way. Thus, the CDM cannot serve as an incentive for less developed countries to participate more actively in international efforts to reduce greenhouse gases. Alternative schemes such as credited NAMAs or carefully designed REDD schemes could help incentivise activities of less developed countries and could partly replace direct payments by market based instruments. If major Annex I countries such as the USA, Canada, Australia and Japan install cap and trade schemes and allow the use of international offset permits, the demand from those countries can only be met if existing offset schemes are restructured. Furthermore, it can be expected that additional schemes for offset generation will be launched by certain parties such as the USA or Japan. Bilateral cooperation, i.e. in the form of sectoral agreements, could deliver a large amount of offset permits.

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Appendix: Advanced PACE Model Description

For the quantitative analysis we use PACE, an established multi-sector, multi-region computable general equilibrium (CGE) model of global trade and energy use. A detailed description of the model structure of the PACE bottom-up CGE model is given in Böhringer et al. (2009). In the PACE model the world is divided into different regions and production sectors.

Three classes of conditions characterise the competitive equilibrium for the model: zero profit conditions, market clearing conditions, and income balance conditions. The first class of conditions determines the price of each output good as the unit cost to produce this good. This cost equals the marginal cost as well as the average cost of production. The market clearance conditions determine the equilibrium activity levels and utility levels as the demand for each good or the real income. They also determine the price levels of the production factors.

A region is represented by microeconomic consumers and each production sector by microeconomic producers. The behaviour of the consumers can be described as choosing the bundle of consumption goods from their budget set that maximises their utility. The budget set is determined by their income from selling the primary factors of production that are assumed to be owned by the consumers. The primary factors of the region include labour, capital and fossil-fuel resources. We also assume that each region obtains an amount of emission permits as an initial endowment.

The behaviour of the producers can be described as choosing a bundle of production goods from their set of production possibilities that maximises their profits. The production possibilities set is determined by their technology, which efficiently transfers the goods and production factors as inputs into a particular output good.

The production of a commodity other than primary fossil fuels is captured by an aggregate production function which characterises technology through substitution possibilities between various inputs. Nested cost functions with three levels are employed to specify the substitution possibilities in domestic production between capital, labour, energy and non-energy, and intermediate inputs, i.e. material.

Final demand in each region is determined by a representative agent, who maximises utility. Total income of the representative household consists of the factors income and tax revenues. Final demand of the representative agent is given as a composite which combines consumption of an energy aggregate with a non-energy consumption bundle. Substitution patterns within the non-energy consumption bundle are reflected by functions that depict expenditure on each good as a fixed proportion of income. The energy aggregate in final demand consists of the various energy goods trading off at a constant elasticity of substitution.

All goods used on the domestic market in intermediate and final demand correspond to a composite of the domestically produced variety and an import aggregate of the same variety from the other regions (the so-called 'Armington good'). Domestic production either enters the formation of the Armington good or is exported to satisfy the import demand of other regions. This assumption prevents specialisation by regions on particular goods.

The use of fossil fuel energy in the production of each good causes a payment of the producers for the associated emissions. These costs can be incorporated into the price of the fossil fuel by making this fossil fuel an aggregate good of pure fossil fuel and associated emissions using a Leontief production function.

Benchmark data determine parameters of the functional forms from a given set of benchmark quantities, prices and elasticities. The underlying data base is GTAP 7 with the base year 2004 which provides a consistent representation of energy markets in physical units as well as detailed accounts of regional production and consumption and bilateral trade flows.

There are equilibria on the markets for production factors labour, capital, natural resources and emission permits. These markets are cleared by the wage rate, the capital rent rate, the rate referring to natural resources or the emission price respectively. The output level, import level and the level of Armington goods, supplied to the economy are determined by total demand for the respective goods. The aggregate goods for the producers can be seen as produced on a sector specific market with associated clearing prices. The market conditions for the consumer goods obtain a similar treatment.

Table 9 Regions and sectors of the PACE model version used for the current analysis

Regions	Sectors	Technologies
- EU and EFTA	FOOD, AGRICULTURE, WOOD	
- India and China	ENERGY	
- Japan	Crude Oil	
- United States and Canada	Natural Gas	
- Brazil and Mexico	Coal	
- Russia and Ukraine	Petroleum and Coal Products	
- Australia and New Zealand (ANZ)	Electricity and Heat	
- South Korea, Indonesia and Malaysia (SIM)		Coal
- Rest of Asia		Oil
- Rest of Latin America		Natural Gas
- Africa		Nuclear
- Rest of the World (ROW)		Renewables
	ENERGY-INTENSIVE (EIS)	
	EIS-ETS (besides Electricity and Petroleum and Coal Products)	
	Iron and Steel	
	Paper Products and Publishing	
	Non-metallic Mineral Products	
	Non-ferrous Metals	
	Air Transport	
	Chemicals, Rubber, Plastics	
	EIS-NETS	
	Transportation (ex. Air and Sea)	
	Mining	
	Construction	
	Machinery	
	Manufacturing	
	Agricultural Products	
	Food Products	
	Wood and Wood Products	
	Transport Equipment	
	REST OF INDUSTRY (incl. Services)	
	Textiles	
	Dwellings	
	Commercial and Public Services	