Overseas Development Institute

Climate negotiations and development

How can low-income countries gain from a Climate Negotiation Framework Agreement?

Nicola Cantore, Leo Peskett and Dirk Willem te Velde

Working Paper 312

Results of ODI research presented in preliminary form for discussion and critical comment

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Contents

Figures and tables

Acronyms

AOSIS	Alliance of Small Island Developing States
AU	Africa Group
BAU	Business as Usual
BRICS	Brazil, Russia, India, China, South Africa
COP	Conference of Parties
EC	European Commission
EPA	Environmental Protection Agency
EU	European Union
GDP	Gross Domestic Product
GEEREF	Global Energy Efficiency and Renewable Energy Fund
IAM	Integrated Assessment Model
IPR	Intellectual Property Rights
LCA	Long Term Cooperative Action
LDCs	Least Developed Countries
NAMAs	Nationally Appropriate Mitigation Actions
ODA	Official Development Assistance
RICE98	The Rice 98 Model
SSA	Sub-Saharan Africa
TRIPS	Trade related Intellectual Property Rights Agreement
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
WDR	World Development Report
WTO	World Trade Organisation

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Executive Summary

Climate change negotiations can have more important welfare consequences for poor countries than other negotiations such as the current trade negotiations. We review key negotiation issues in the run-up to Copenhagen climate change negotiations, set out key scenarios and model their effects on incomes in poor countries. The paper suggests that developing countries gain from emissions stabilising policies as they enjoy lower environmental damages but they suffer a reduction in Gross Domestic Product (GDP) if they themselves are subject to emissions stabilising policies without a breakthrough in technological change. Climate finance can enhance GDP in developing countries, but they will only stimulate green growth if public finance initiatives do more than substitute for domestic investments.

We consider three main negotiation issues: emissions reductions, technology transfer and climate finance. Using an Integrated Assessment Model (RICE98) which includes negative effects of environmental damages on income levels, albeit in a relative conservative way, we find that sub-Saharan Africa (SSA) can gain 1% of (accumulated) GDP by negotiating strong emission reductions (e.g. 80%-95% cuts on 1990 levels by 2050) in developed countries, but would lose up to 2% of GDP if it takes on emission reductions (15% by 2020) itself. Cheaper green technology, in developed and developing countries will raise incomes of developing countries considerably.

Climate finance (which is additional to current aid commitments) to Africa for adaptation and mitigation can raise SSA incomes, but it is crucial to understand which levels of finance to negotiate for. For example, funds for mitigation and adaptation worth $ 28 billion per year (in 1990 prices and hence corresponding the estimates contained in the EC blueprint) alleviates GDP losses for developing regions such as Africa when it reduces emissions by 15% by 2020 although the scenario still leads to a loss in GDP compared to a Business as Usual (BAU) scenario in which no action to reduce emissions is taken. So additional climate finance goes some way to compensate for reduced emissions.

Scaled-up climate finance worth around $ 95 billion per year (within the range of the WB's WDR 2010) and available equally for all developing countries according to their levels of income per capita, leads to a *gain* of around 0.2% of GDP (again assuming Africa is subject to a 15% emissions constraint by 2020) compared to a BAU scenario.

The scenarios of greatest economic value to Africa are those in which there are ambitious cuts in developed and large developing country emissions, large finance packages but no specific emissions constraints for poor countries, in which case transfers from rich to developing countries enhance growth, reduce emissions and allow an earlier introduction of domestic purchases of backstop technologies. This scenario would raise Africa's GDP by up to 6% (compared to BAU).

The paper clearly shows that various negotiation outcomes can have substantial and differential development effects on developing countries. Further work could shed light on the details of specific negotiation issues and the sensitivity of the results to using different model specifications.

1. Introduction

Climate change negotiations can have more important consequences for incomes of poor countries than other negotiations such as the current WTO (World Trade Organization) Doha round[1]. In Copenhagen, developed and developing countries have the chance to strike a global deal, or at least set a framework agreement on emissions targets, environmental technology transfer, finance for adaptation to climate change and several other issues. All of these issues affect economic growth and well-being in poor countries. But what are the key substantial issues in the current climate change negotiations and what are the economic effects of these negotiations? Which negotiation issues might have the greatest impact on development in low-income countries?

In the run-up to Copenhagen, negotiation positions have become clearer although many crucial issues are still undecided. The European Union (EU) and United States (US) still need to set in stone their own emission reductions and at the same time they suggest that emerging markets also need to make their own emission reductions. Poor countries aim for mandated technology transfer to their countries and argue for substantial funds to finance the costs of adaptation. The effects of different negotiation options on the issues for poorer countries have not been agreed.

This paper deals with these issues by taking stock of the climate change negotiations, describes key stumbling blocks (Section 2) and, on the basis of this, develops meaningful negotiation scenarios (Section 3) that are then used on an Integrated Assessment Model (IAM), RICE98 (Nordhaus, 1999), to simulate the effects on income in poor countries. Section 4 discusses the results. Section 5 concludes.

Whilst this paper contributes to an understanding of the broad effects of the Copenhagen negotiation options using models, there is much work left to do in order to fully understand the possible effects of climate negotiations on poor countries. For example, there is very little analysis of the effects of how a carbon constrained world affects poor countries, and how these can be properly built into models.

[1] This does not undermine the value of a Doha deal. Some estimate that even sub-Saharan Africa's Gross Domestic Product (GDP) could gain from a Doha Round by around 0.1% by 2015 (table 17.6 in Anderson et al, 2006). World GDP could increase by 0.23%.

2. The UNFCCC negotiation process

A number of negotiation blocks have emerged in the course of the climate change debate. Some of these are individual countries and some are alliances amongst countries with similar negotiating positions. Some of the key negotiation blocks include:

- EU,
- US,
- Alliance of Small Island Developing States (AOSIS),
- Africa Group (AU),
- G-77 (+China).

These country blocks have different negotiation stances on key issues, based upon underlying drivers such as projected impacts of climate change on their economies, divisions of responsibility between north and south etc. In the run-up to Copenhagen, a large number of negotiation issues have come to the fore. Three key issues include:

- The level, nature and distribution of emissions targets;
- Commitments and approaches to technology transfer from developed to developing countries;
- The level, distribution and aims of climate finance.

The different positions that are taken by the different country blocks are discussed below.

2.1 The level, nature and distribution of emissions targets

The major issues in the debate about emissions targets centre on:

- The level of country targets;
- The distributional aspects of targets by different groups of countries targets (see Cantore and Padilla, in press), especially which countries take on which targets (particularly whether certain large developing countries should take on targets, when and at what level);
- The nature of targets – whether they are binding or non-binding; intensity or emissions based etc.

The EU position (currently led by Sweden) is regarded as one of the most ambitious of the developed countries. The European Council's recent statement on Copenhagen calls for aggregate developed country emission reductions of 30% by 2020 if other developed countries commit to similar reductions. Further they call for cuts in developed country targets of between 25 - 40% below 1990 levels and by 80-95% by 2050, and for developing countries to deviate from their currently predicted growth rates in emissions to the order of 15 -30% by 2020.

The US position, by contrast, is much less ambitious as it considers as benchmark the 2005 level of emissions rather than 1990. The current position is a 17% reduction on 2005 emissions levels by 2020 (3% below 1990) and 80% of 2005 by 2050. Current policy proposals will have to be met by the US Senate first.

Developing countries argue for ambitious action by all developed countries. AOSIS and Least Developed Countries (LDCs) are calling for 45% reductions on 1990 levels by 2020 and 85% by 2050. The African Group has called for developing countries to reduce their overall carbon emissions by at least 95% below 1990 levels by 2050. This shall be achieved during subsequent commitment periods by the end of 2050 [Long Term Cooperative Action (LCA) negotiation text, 2009].

A key debate in terms of the distribution and nature of targets centres around whether emerging economies such as China should take on binding emissions reduction commitments. Several key developed countries such as the US favour 'binding' emissions targets for major developing countries, in particular China and India. Specifically, the US has called for developing countries to submit

Nationally Appropriate Mitigation Actions (NAMAs) in the 2020 timeframe that are quantified and also specify a date when developing countries should take on binding commitments. Emerging economies, in particular Brazil, Russia, India, China, South Africa (BRICS), are opposed to binding targets and any separation from other developing countries in terms of their commitments. However, some have recently announced emissions reduction or energy intensity commitments (e.g. China plans to cut its energy consumption by 20% by 2020 and plans to increase its use of renewable energy to 15% of overall consumption while reducing the use of coal-fired energy plants[2]). South Africa, the LDC and AU have shown more leniencies towards compromise options, such as no-lose sectoral crediting approaches. This is partly because LDCs will stand to gain from larger developing countries taking on commitments as soon as possible. However, in formal communications the existing division between developed and developing countries is still upheld (Goltz 2009).

2.2 Commitments and approaches to technology transfer from developed to developing countries

The main debates on technology transfer include:

- Financial commitments from developed countries to support technology transfer;
- The institutional structure governing technology transfer from developed to developing countries;
- International laws governing technology diffusion (e.g. intellectual property rights; links to trading regimes etc.).

China and G-77 have proposed a Multilateral Technology Acquisition Fund, managed by a new subsidiary body to be established under the United Nations Framework Convention Framework on Climate Change (UNFCCC). This body would plan, coordinate, fund, and monitor technology transfer, based on the technology needs specified in each NAMA. The fund would be raised from developed-country public resources. India has similar views on technology transfer. It proposes establishing an Executive Board of Technology under the Conference of Parties (COP) to oversee a technology fund with the assistance of a secretariat. The LDC Group and AOSIS supports the China proposal for a technology window, established in the new financial mechanism under the control of the COP, which shall support implementation of concrete and practical technology activities.

Within this perspective current financial channels for technology transfer such a Global Energy Efficiency and Renewable Energy Fund (GEREEF) could be strengthened and improved during negotiations. GEREEF, introduced by the European Commission, has been designed to accelerate the transfer, development and deployment of environmentally sound technologies. As energy efficiency and renewable energy projects face significant difficulties in raising commercial funding, GEREEF aims to help overcome these barriers by providing new risk-sharing and co-financing options to mobilize international and domestic commercial investments.

In the field of innovation diffusion the Trade related Intellectual Property Rights Agreement (TRIPS) prescribing a 20 years protection of patents represent an obstacle to the spread of knowledge towards developing countries. In terms of technological Intellectual Property Rights (IPR) legislation in spite of the European Union position supporting ‘research, development and demonstration’ India also proposes ‘manufacture, commercialization, deployment and diffusion’ of technologies.

The mechanisms of technology transfer (induced by financial mechanisms or by appropriate laws) crucially affect the market penetration of green technologies and, as outlined by Stern (2006), their production costs and market prices. As a consequence of a higher rate of penetration and diffusion of renewable sources of energy and abatement technologies induced by knowledge transfers, green technologies will become cheaper for developing countries and this will encourage a faster transition towards a green economy in the long run.

[2] http://www.financialpost.com/story.html?id=2138608#ixzz0VnzibRMA

2.3 The level, distribution and aims of climate finance

The main debates on climate finance include:

- The level of finance provided by developed countries to developing countries for mitigating and adaptation to climate change;
- Mechanisms for raising such finance;
- How finance between adaptation and mitigation is divided;
- Financial instruments (e.g. public funds; private sector investment; carbon markets);
- Governance of financial mechanisms, particularly surrounding who manages finance and developing country access.

This paper is mostly interested in the level of additional finance needed.

The EU has relatively high estimates, at least amongst developed countries, for financing climate change adaptation and mitigation in developing countries. The annual total net incremental cost of adaptation and mitigation would amount roughly to €100 billion by 2020 with €22-50 billion coming from public sources. The US estimations are more conservative. Recent Environmental Protection Agency (EPA) analysis indicates that the American Clean Energy and Security Act of 2009 would allocate approximately $3.4-5.4 billion annually by 2020 for direct climate change assistance from the US government to developing countries ($476-786 million for clean technology deployment, $2.4-3.8 billion for international forest conservation, and $476-768 million for adaptation) (see Dervis and Jones, 2009). For the financial year 2010 the administration has sought over $1.2 billion in direct spending on international action on climate change including $313 million for adaptation, $745 million for clean energy (much of this through a new Clean Technology Fund), and $170 million for forests, principally through the World Bank's Carbon Partnership Facility (Brookings 2).

How does this compare to developing country positions? Algeria, on behalf of the Africa Group earlier this year called for financial flows to support adaptation in developing countries of at least $ 67 billion/year by 2020 and a 2020 target for the scale of financial flows to support mitigation in developing countries is set at $ 200 billion by 2020 (0.5% of GDP of Annex II Parties) (FCCC/AWGLCA/2009/MISC.4: 13). The LDC Group and AOSIS have called for similar levels of funding, at 1% of global GDP or approximately $400 billion annually in addition to development aid (AOSIS/LDC press release August 2009). Larger developing countries are calling for similar levels of funding, with India suggesting '…assessed contributions equal to at least 0.5% of the GDP of the Annex I Parties' and China suggesting that 'developed country Parties shall make assessed contributions by a percentage of annual GDP, e.g. 0.5-1%, in addition to the existing Official Development Assistance (ODA).' (FCCC/AWGLCA/2009/MISC.4: 68). (Goltz 2009).

3. The negotiation scenarios

Using the key negotiation issues as discussed in the previous section we develop a set of scenarios relating to emissions target, technology and climate finance. The Business as Usual (BAU) is the baseline scenario which assumes that no region takes any action against global warming. All scenarios will be run on the RICE98 model, see the appendix for details, and Cantore (2009) for a discussion of the different types of models. RICE98 includes a link between environmental damages and incomes, albeit in a conservative way.[3] Simulations are run over the period 1995 – 2205, but the results are reported for the period 1995 – 2105.

3.1 Emissions targets

We develop two main scenarios on emissions targets:

- In the first scenario (ER-80) developed countries (Japan, USA, Europe, High Income Countries, Russia and Eastern Europe Countries)[4] will reduce their emissions by 80% by 2050 compared to 1990 as proposed in the last G20 meeting; a variant of this scenario considers a 95% emissions reduction as proposed in the European Commission (EC) blueprint (ER-95).
- The second scenario assumes that all developing regions (including OPEC countries, Middle-Income Countries, Low-Middle-Income Countries, Low-Income Countries, China, India and Africa) are committed to reduce 15% of BAU emissions by 2020 (see EC blueprint proposal), in addition to the 80% emissions reduction commitment in developed countries (ER-80-15). 2020 emissions for developing countries are estimated according to the RICE98 level of emissions in a BAU scenario. We also simulate a 95% (instead of 80%) emission reduction in the last scenario which is called (ER-95-15).

The following table summarises the scenarios.

Table 1: Description of the emissions target scenarios

Scenarios	Description
ER- 80	Rich countries are committed to cut 80% of 1990 level of emissions by 2050
ET-80-15	Rich countries are committed to cut 80% of 1990 level of emissions. Developing countries are committed to cut by 2020 15% of 2020 emissions by 2050
ER – 95	Rich countries are committed to cut 95% of 1990 level of emissions by 2050
ER – 95 – 15	Rich countries are committed to cut 95% of 1990 level of emissions by 2050. Developing countries are committed to cut by 2020 15% of 2020 emissions

The RICE98 model is structured so that each region follows an optimal growth path maximizing the level of consumption per capita and gradually changes the trajectory of emissions over time to meet the emissions constraint in an efficient way. We also assume that beyond 2050 developed countries stabilize the level of emissions at 2050 levels. The same hypothesis is assumed for developing countries after 2020.

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[3] WDR (2010, p.8) shows that estimations of climate change damages as % of the baseline level of consumption without global warming are lower with Nordhaus' assumptions compared to Stern's assumptions. Moreover in this paper we use Nordhaus' optimistic assumption of a declining pure rate of time preference (around 0.25% per year from a 3% level in 1995) which attaches a higher weight to future global warming impacts in the optimisation process and that generates lower global emissions and climate change damages over time in a BAU scenario. Results about the present value of cumulated GDP in different scenarios are then elaborated at a 3% discount rate.

[4] For a more detailed description of the RICE98 model aggregation see Appendix A.

3.2 Technology

The RICE98 model assumes that each region produces output trough capital, labour, a carbon source of energy and a backstop technology. According to Nordhaus (p. 41): 'The basic assumption is that there are sources of carbon removal (such as carbon scrubbing or carbon sequestration in trees) that can be undertaken in large scale but at a relatively high price. These are assumed to be substitutes for carbon fuels at the wholesale level, and therefore are calculated with the mark-up. An alternative interpretation is that a non-carbon fuel is introduced that is a perfect substitute for carbon fuels.' Therefore the backstop technology can be interpreted as energy or abatement innovations encouraging the transition towards a decarbonised economy. The Garnaut Climate Change Review for Australia (2008) explains that: 'At some time, there will be breakthroughs that fundamentally lower the costs of producing goods and services in the low-emissions economy... These backstop technologies will take carbon dioxide from the air at some cost, without relevant limit, and so end the inexorable rise in the carbon price. Research is currently proceeding around the world on a number of possibilities, both industrial and biological.'[5]

We develop two key scenarios to simulate technology transfers by assuming a future introduction of a backstop technology in rich countries dropping the price of emissions reduction. As the great uncertainty about the modalities by which green innovations will take place we assume guess values for the timing and magnitude of the pricing shock.

- In the scenario Technology1 we assume a reduction in the price of the backstop technology in High Income Countries and Medium Income countries but not in African and Low-income Countries region. This scenario is based on the assumption that from 2045 rich regions experience a technological breakthrough that halves the price of green technologies. The scenario assumes a situation in which African and Low-income countries cannot enjoy this innovation and cannot use the backstop technology with a lower price (in RICE98 the price of the backstop technology is $300 per ton + a mark up component that is different for each region) due to barriers in the adoption of green technologies.
- The second scenario, Technology 2, is optimistic and assumes that the green innovation in 2045 can immediately be adopted by Low-income countries and Africa. This is a scenario in which we assume that there are no legal or financial restrictions on the international diffusion of clean technologies. Poor countries can also use the backstop technology with a 50% price reduction.

Both scenarios relax the market penetration constraints common in the RICE98 model concerning green backstop technologies (cap of 50% consumption increase every 10 years). Table 2 summarises the technology scenarios.

Table 2: Description of the technology scenarios

Scenario	
Technology 1	In 2045 a technological shock halves the price of a backstop technology for all countries except Africa and Low-income Countries. Barriers to technology transfers do not allow Low-income Countries and Africa to use a cheaper backstop technology
Technology 2	In 2045 the introduction of a green backstop technology halves the consumption price of the backstop technology for all countries

3.3 Additional climate finance

In the area of climate finance we develop two scenarios based on estimates in the European Commission Blueprint and the World Bank Development Report 2010 on Climate Change and Development.

[5] The Garnaut Review for climate change also highlights interesting examples of future backstop technologies: 'In Australia, the most interesting work on what could become backstop technologies are in the applied biological sciences—areas of traditional Australian scientific and economic strength. One of these, the use of algae to convert carbon-rich wastes or carbon dioxide from the air into stable carbohydrates, would utilise the biological processes that converted an earlier carbon-rich atmosphere of earth to the oxygen-rich air that made life possible for mammals and therefore humans. They would enhance natural processes by selecting organisms and their growing conditions specifically for the sequestration task'.

The EC blueprint assumes that rich countries (in the RICE98 model Japan, USA, Europe, Other High Income Countries, Russia and Eastern Europe Countries) will reduce their emissions by 80% by 2050 and developing countries (OPEC countries, Middle Income Countries, Low Middle Income Countries, Low-income Countries, China, India and Africa) by 15% by 2020. It further assumes that international public finance climate change needs of developing countries vary in the range € 10 – 20 billion for mitigation and € 10 – 24 billion for adaptation per year.

- The first scenario (EC_blueprint) assumes average values within the range of hose estimated by the EC and that rich countries transfer $ 13 billion (in 1990 constant prices[6]) until 2020 to Africa and Low-income Countries (not including China and India) for mitigation which is used to buy a green backstop technology and $ 15 billion, in 1990 prices, for adaptation to reduce damages from climate change. We assume that the same funding mechanism is still in place beyond 2020. Climate finance will not go to emerging economies, as the EC blueprint argues that, 'many developing countries, especially the economically more advanced ones, have sufficient own financial resources at their disposal to stimulate the necessary domestic investment'.
- The second scenario, labelled World Bank (WB) is based on different estimates on the need for climate finance as discussed in the World Development Report (WDR) 2010 which points out that the need of climate financing for developing countries is between US$ 264 to US$ 565 billion for mitigation by 2030 (at 2005 prices) and 15 to 100 billion for adaptation per year. In scenario WB we assume that 30% (EC estimates a range from 20% to 40%) of this finance requirement is covered by international public finance, so that we assume there will be a public transfer to developing countries within this range corresponding to around 1990 US$ 83 billion of 1990 per year until 2030 for mitigation and 1990 US$ 12 billion for adaptation, and addressed to a wider range of developing regions (Africa, LI, China and India). Developing countries use mitigation finance to buy a backstop technology and adaptation finance to reduce climate change damages more generally. The same funding mechanism is in place beyond 2030.

Four regions (Japan, USA, Europe and Other High Income Countries) contribute to the funds according to the "ability to pay" principle, so there are less funds available in these regions to the benefit of the poorer regions. The total amount of money is shared across the poorest countries (Low-income Countries, China, India and Africa) according to their levels of GDP per capita. Table 3 shows the distribution of charges and benefits assumed for developed and developing countries. Market penetration constraints of the backstop technology common in the RICE98 model (cap of 50% consumption increase every ten years) are relaxed in both scenarios.

Table 3: The providers and beneficiaries of climate finance 1990 $ per year

	EC_blueprint	WB
Japan (provider)	8.12	27.55
USA (provider)	7.56	25.65
Europe (provider)	6.16	20.90
Other High Income Countries (provider)	6.16	20.90
LI (beneficiary)	9.24	18.05
China (beneficiary)	-	16.15
India (beneficiary)	-	23.75
Africa (beneficiary)	18.76	37.05
Total	28	95

An implicit assumption behind these scenarios is that developing countries spend funds efficiently. We acknowledge that in many developing countries funds could be diverted locally for other purposes rather than the ones agreed during negotiations, although we do not incorporate this into our work. In

[6] Please see Annex B

the scenarios, mitigation funds are used by developing countries to purchase green inputs (backstop technology) to enhance green growth. Adaptation funds are lump sum transfers compensating climate change costs that may not be spent by developing countries for environmental purposes.

Table 4: Description of scenarios: Additional climate finance

Scenarios	Description
EC_blueprint	80% of emissions reduction target for all rich countries relative to 1990 levels by 2050 and 15% of emissions reduction for all developing countries relative to 2020 levels by 2020. The richest regions (USA, Japan, Europe and Other High Income Countries) transfer to Africa and Low-income Countries 28 billion of 1990 US$ (13 for mitigation and 15 for adaptation) per year.
WB	80% of emissions reduction for all rich countries relative to 1990 levels by 2050 and 15% of emissions reduction for all developing countries relative to 2020 levels by 2020. The richest regions (USA, Japan, Europe and High Income Countries) transfer to Low-income Countries, China, India and Africa 95 billion of 1990 US$ (12 for adaptation and 83 for mitigation) per year.

4. Which negotiation outcomes are best for development?

4.1 Emission target scenarios

Not surprisingly in terms of sustainability the best scenarios for which we observe the lowest temperature increase are ER-95-15 and ER-80-15 as they assume the highest global emissions reduction effort. These scenarios reduce the level of GDP for developing countries that are subject to these emissions constraints, see table 5. In the scenarios ER-80 and ER-95 which excludes emissions reductions by developing regions, GDP in developing countries increases, as they will face less environmental damages but they do not bear the same costs (see WDR 2010 for a discussion on why Africa countries bear the highest costs of climate change). As it is evident in Nordhaus and Boyer (2000) and in other contributions results are quite consistent as developing countries suffer from mitigation policies. The only exception in our study is India which obtains GDP increases in all mitigation scenarios. This result is consistent to a recent policy paper (Climate Group, 2009) that predicts GDP level increases in India in most of the mitigation scenarios. Within the RICE98 model framework and our assumed scenarios design this can be explained by the evidence that the reduction of environmental damages in India is higher than abatement costs.

Figure 1: Temperature increase compared to 1900 levels (degrees Celsius)

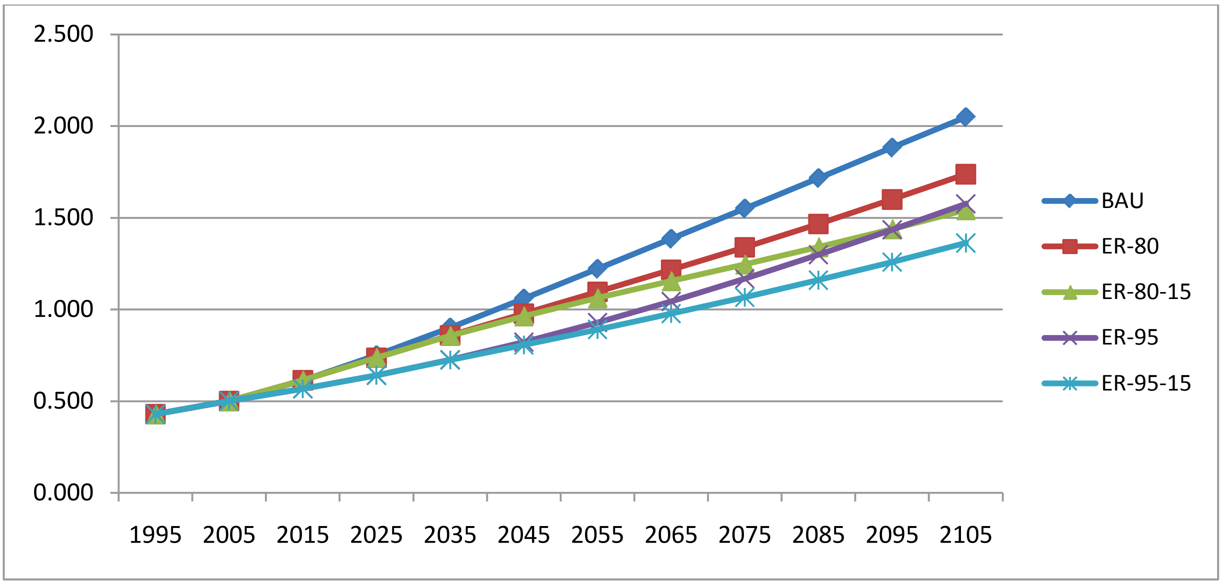


Table 5: Effects of various emission reduction paths on GDP

	ER-95	ER-80	ER95-15	ER80-15
LI	0.812	0.485	-0.815	-1.113
China	0.274	0.179	-0.222	-0.262
India	1.316	0.798	0.572	0.106
Africa	1.036	0.600	-1.199	-1.645

Note: Discounted sum of GDP (net of environmental damage) in the lapse of time 1995 - 2105. % of change compared to a BAU scenario. 3% discount rate

4.2 Technology

The reduction of the backstop technology price generates large benefits for developing countries. Even in the scenario Technology1, where poor regions such as Africa and Low-income Countries do not enjoy the benefits of innovation as we assume there is scarce technological diffusion, they experience higher levels of GDP. In the Technology1 scenario poor countries suffer less environmental damages driven by reduced pollution and a higher penetration of green innovation in richer countries. In the Technology 2 scenario poor countries, beyond the benefits for less environmental damage, also pay a reduced energy bill and this represents a further growth enhancing factor (see Cantore and Te Velde, 2009, for an additional firm-level discussion linking productivity and energy efficiency).

Figure 2: Temperature increase since 1900 levels. (Celsius degrees)

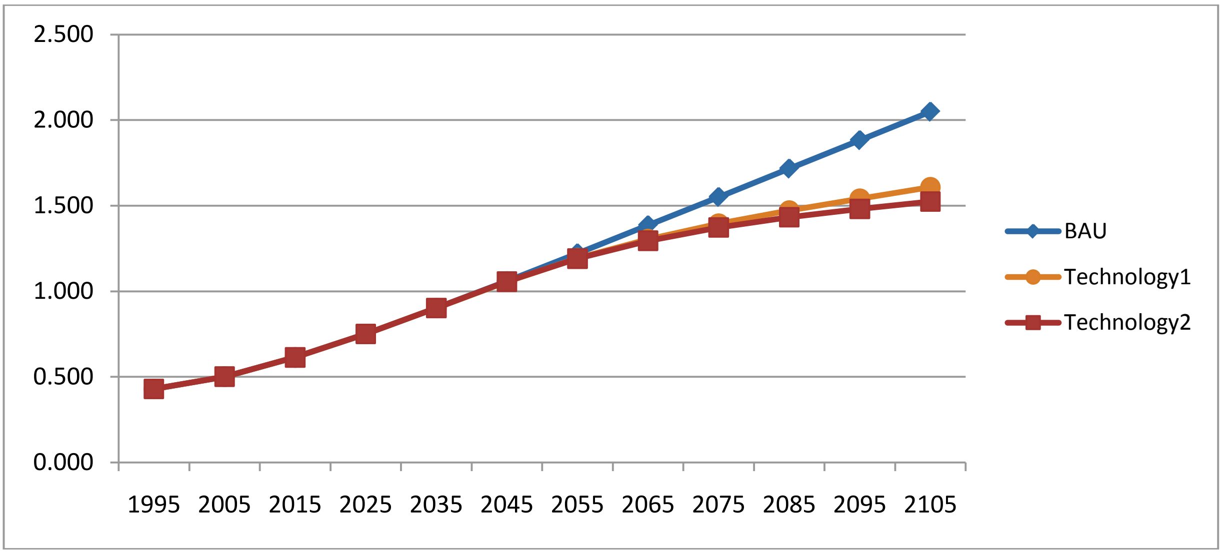


Table 6: Effect of various technology transfer technology scenarios on GDP

	Technology1	Technology2
LI	0.567	1.493
China	1.663	1.678
India	2.788	2.904
Africa	0.624	3.286

Note: Discounted sum of GDP (net of environmental damage) over 1995 - 2105. % difference from BAU using a 3% discount rate

4.3 Additional climate finance

The modelling outcomes suggest that the temperature increase in the climate finance scenarios is lower than in the BAU baseline. This finding is unsurprising as we are assuming an emissions constraint for both developed (80% by 2050) and developing countries (15% by 2020). The interesting point is to examine the effects on GDP in developing countries. From this point of view it is instructive to compare the ET-80-15 scenario assuming an emissions reduction constraint for developing countries but excluding financial programmes with scenarios assuming the same emissions reduction but including climate finance scheme transfering funds from rich to poor regions.

The EC blueprint scenario involves a lower flow of money (1990 $ 28 billion vs 95 billion per year) and is addressed towards a restricted number of regions (2 vs 4) than the WB scenario. The estimates in table 7 suggest that when developing countries are involved in emissions reduction activities, climate finance programmes reduce GDP losses deriving from mitigation activities, especially in the WB scenario. In the context of the same emissions reduction, the lowest costs and higher cumulated GDP levels are associated to the scenario assuming the most extensive flow of transfers towards developing countries.

A further result is that climate finance programmes raise incomes, but not necessarily green growth. Table 8 suggests that domestic expenditures for the backstop technology are delayed for developing countries and in all scenarios we do not register changes in global temperatures and carbon emissions (see ER-80-15, EC_blueprint and WB scenarios in figure 3). Hence from a sustainability perspective it is important to implement climate finance programmes in such a way that this also enhances domestic investment in abatement technology and 'green' business entrepreneurship over time.

Figure 3: Temperature increase since 1900 levels. (Celsius degrees)

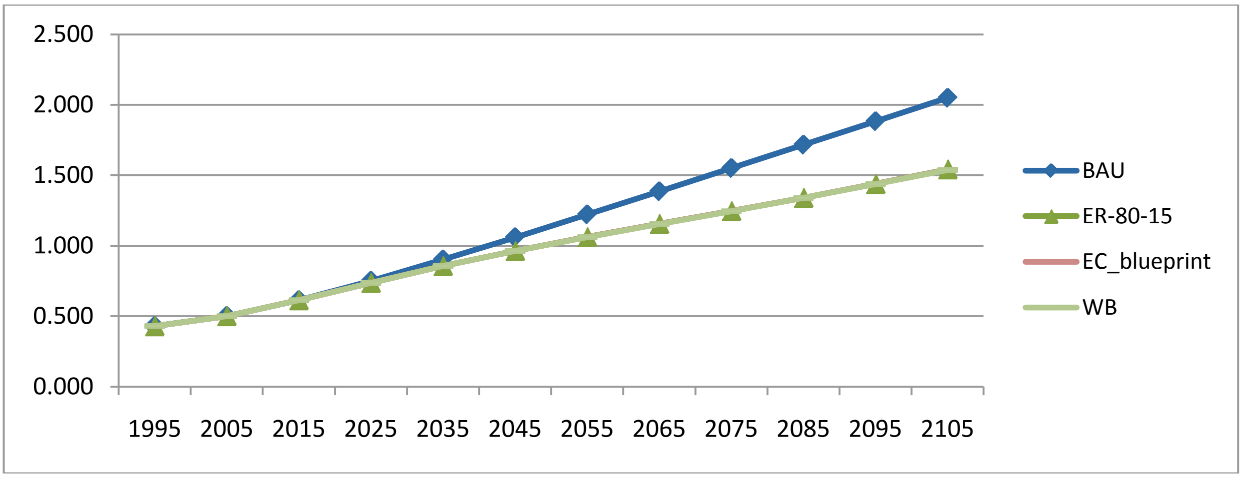


Table 7: Effect of climate finance and emission reduction packages on levels of GDP

	ER-80-15	EC_blueprint	WB
LI	-1.113	-0.811	-0.624
China	-0.262	-0.520	-0.270
India	0.106	0.073	0.646
Africa	-1.645	-0.622	0.289

Note: Discounted sum of GDP (net of environmental damage) over 1995 - 2105. % difference from BAU using a 3% discount rate

Table 8: Date of the first domestic purchase of backstop technology in developing countries

	ER-80-15	EC_blueprint	WB
LI	2035	2055	2055
China	2025	2065	2055
India	2035	2055	2055
Africa	2015	2025	2035

4.4 What is good for Africa?

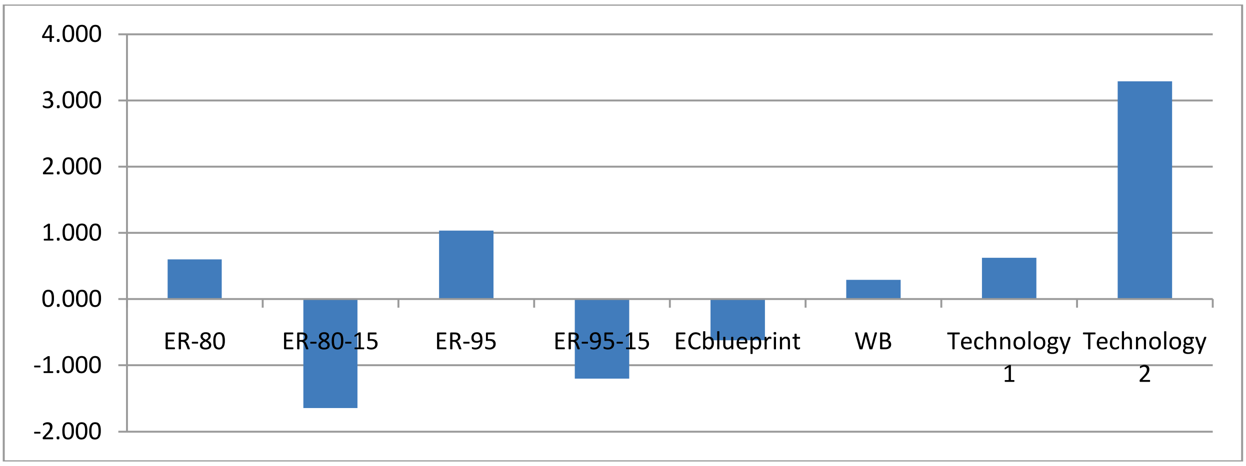
Negotiations have their own dynamics and motives. The analysis of the economic effects on Africa (this includes the poorest countries in sub-Saharan Africa) offers one perspective on what negotiation options are best.

Figure 4 summarises the results for Africa:

- Africa *gains* 1% of accumulated GDP (i.e. around 2% of GDP in 2105) from strong emission reductions (e.g. 80%-95% by 2050) in developed countries (even if this means lower GDP in developed countries); this is far bigger than estimates of the possible gains from say the current WTO round.
- However, when it needs to take on its own commitments as well (e.g. 15% reductions) it will *lose* up to 2% of accumulated GDP.
- Environmental technological innovation is an important growth opportunity in Africa and is even more important if knowledge can spread towards poor regions. International laws about the diffusion of property rights and measures for the spread of technology will be a crucial issue during Copenhagen negotiations.

Climate finance programmes are necessary to alleviate mitigation costs of Africa and to reduce climate change damages. Interestingly in the WB scenario transfers for Africa addressed to mitigation activities and to reduce climate change damages more than offset costs to reduce emissions. In this case the level of cumulated GDP is higher than in the BAU scenario that does not assume any emissions constraints for Africa. Climate finance programmes as contained in the EC blueprint reduce mitigation costs for Africa (c.f... compare EC_blueprint and ER-80-15).

Figure 4: Effects of possible climate change negotiation outcomes on African GDP



Note: Discounted sum of GDP (net of environmental damage) over 1995 - 2105. % difference from BAU using a 3% discount rate.

The previous results suggest that African countries ought to negotiate for appropriate amounts of climate change funds, policy packages that guarantee technology transfers and strong emission reductions in developed countries.

One further question relates to whether the poorest countries would need to be involved in international emissions reduction policies? In some previous scenarios we suggest they do, but we also simulate exceptions for Africa and other low-income countries.

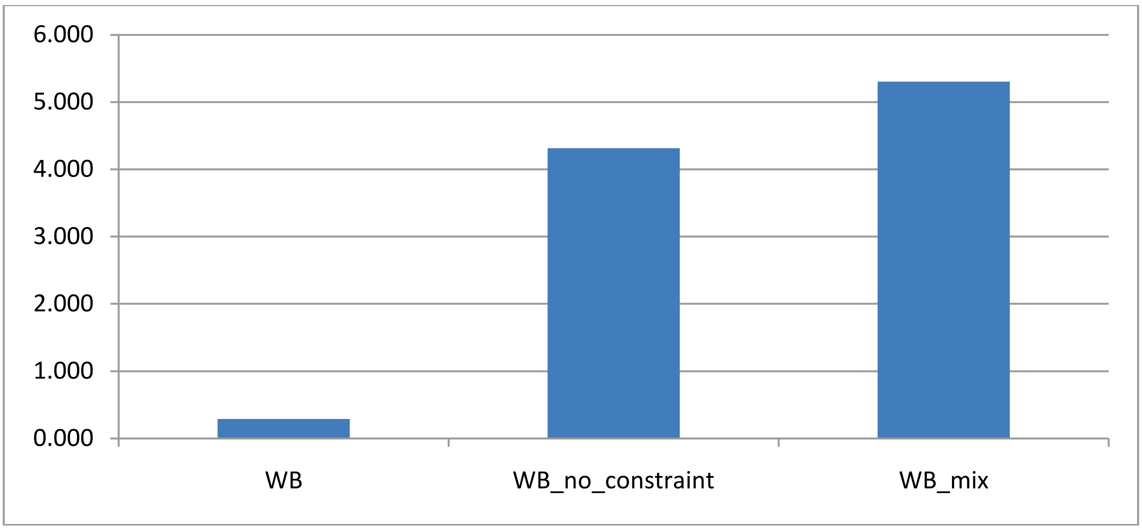
We consider two variants of the WB scenario. In the WB_no_constraint scenario we assume that low-income countries and Africa receive climate finance but are not subject to emissions constraints. In the WB_mix scenario we also assume a 50% price halving of the backstop technology in 2045 for all regions. In all scenarios, there is an 80% reduction of developed country emissions. Table 9 summarises scenarios.

Table 9: Further scenarios for low-income and African countries

Scenario	Description
WB	80% of emissions reduction for all rich countries relative to 1990 levels by 2050 and 15% of emissions reduction for all developing countries by 2020 relative to 2020 levels. The richest countries (USA, Japan, Europe and Other High Income Countries) transfer to developing countries an additional 95 billion of 1990 US$ (12 for adaptation and 83 for mitigation) per year. Funds are collected through an "ability to pay" principle and distributed to Low-income Countries, China, India and Africa according to their levels of income per capita.
WB_no_constraint	80% of emissions reduction for all rich countries relative to 1990 levels by 2050 and 15% of emissions reduction by 2020 for all developing countries (except Africa and Low-income Countries) relative to 2020 levels. The richest countries (USA, Japan, Europe and Other High Income Countries) transfer to developing countries an additional 95 billion of 1990 US$ (12 for adaptation and 83 for mitigation) per year. Funds are collected through an "ability to pay" principle and distributed to Low-income Countries, China, India and Africa according to their levels of income per capita.
WB_mix	80% of emissions reduction for all rich countries by 2050 relative to 1990 levels by 2050 and 15% of emissions reduction by 2020 for all developing countries (except Africa and Low-income Countries) relative to 2020 levels. The richest countries (USA, Japan, Europe and Other High Income Countries) transfer to developing countries an additional 95 billion of 1990 US$ (12 for adaptation and 83 for mitigation) per year. Funds are collected through an "ability to pay" principle and distributed to Low-income Countries, China, India and Africa according to their levels of income per capita. A technological shock in 2045 halves the price of the backstop technology for all regions.

We compare the effects of the simulations on cumulated GDP, the year of introduction of domestic backstop technology purchases and cumulated carbon emissions in Africa. As expected, Africa in the WB_no_constraint and the WB_mix scenario yields higher levels of cumulated GDP as showed in the figure 5 because enjoys lower environmental damages from mitigation policies in other regions and growth enhancing financial transfers without bearing the costs of emission constraints.

Figure 5: The effects of combined climate change packages including additional climate finance programmes on level of GDP



Note: Discounted sum of GDP (net of environmental damage) over 1995 - 2105. % difference from BAU using a 3% discount rate.

An interesting result is that scenarios that do not involve an emissions constraint are also preferable from a sustainable point of view. As table 10 suggests, higher levels of GDP allow Africa to obtain more resources to stimulate early domestic purchases of backstop technologies. WB_no_constraint and WB_mix scenarios are win – win as they enhance growth in Africa, reduce emissions and encourage an early transition towards green technologies. If we compare the WB_mix and the WB_no_constraint scenario, the introduction of a backstop technology is earlier in the WB_no_constraint scenario than in the WB_mix scenario as African countries tend to postpone domestic purchases of green technologies towards 2045 when the price of the backstop technology decreases.

Table 10: Cumulated carbon emissions (Gigatons of carbon) for Africa. % change relative to a BAU scenario

	Cumulated emissions
WB	- 41.87
WB_no_constraint	- 57.10
WB_mix	- 57.54

Table 11: Date of the first domestic purchase of backstop technology in developing countries

	WB	WB_no_constraint	WB_mix
Africa	2035	2015	2025

5. Conclusions and issues for future debate

The conclusions of this paper include:

- Developing countries gain from emissions stabilising policies in developed countries as they experience lower environmental damages but they suffer GDP reductions if they too are subject to emissions stabilising policies;
- Technology innovation in rich countries and the mechanisms to spread easily technology towards developing countries will be crucial to reconcile growth and sustainability.
- The amount of transfers from climate change programmes is crucial to involve developing countries in mitigation policies. An appropriate amount of funds to compensate mitigation and to reduce developing countries` climate change damages will be important during negotiations to widen international participation in emissions reduction efforts.
- Climate finance programmes may not stimulate green growth when public finance initiatives substitute for domestic investments in green technology in a context where developing countries are subject to emissions constraints from 2020. An early and binding emission constraint for developing countries reduces domestic available resources for environmental purposes.

For Africa (SSA) in particular:

- Africa can *gain* 1% of cumulated GDP by negotiating strong emission reductions (e.g. 80%-95% by 2050) in developed countries;
- Africa can gain 3% of cumulated GDP if in the future a backstop technology will be available and will be as competitive as carbon sources of energy.
- Climate finance to Africa for adaptation and mitigation can raise African growth; but it is crucial to understand which numbers to negotiate for and to ensure that climate finance is not a substitute for own efforts to engage in productivity enhancing green technologies.
- Agreements that do not involve an emission constraint for Africa and low-income countries are win–win compared to scenarios in which Africa is constrained to a fixed level of emissions. Those scenarios increase GDP levels and reduce emissions as higher levels of GDP allow developing countries to use earlier a backstop technology and to stimulate domestic investment for green growth. In a scenario that combines climate finance based on the World Bank estimates, an exogenous technological shock in 2045 reducing the price of an environmental friendly technology, strong emissions reductions in developed and large developing countries and the absence of emissions constraints, Africa can gain up to 6%of cumulated GDP until 2100.

Of course the results in this paper depend on model assumptions, model calibration and the details of the scenarios. For example, RICE98 does not capture international trade or capital linkages or does not include equations describing the mechanisms governing the spread of technological knowledge at international level. As outlined by the Stern Review:' Broader behavioural modelling exercises suggest a wide range of costs of climate change mitigation and abatement, mostly lying in the range -2% to + 5% of annual GDP by 2050 for a variety of stabilisation paths'. In spite of these limits and of the difficulties arising when researchers investigate the consequences of uncertain future scenarios through stylized models frameworks, each analysis represents a valuable contribution to suggest the best policies to tackle climate change. This paper informs policy makers for the Copenhagen negotiations comparing the importance of different types of negotiation issues for poor countries. It will be interesting to compare our work with other similar exercises.

Different negotiation outcomes of a Copenhagen framework agreement will have different effects on different countries. The scenarios of greatest economic value to Africa are those in which there are ambitious cuts in developed and large developing country emissions, large finance packages but no specific emissions constraints for poor countries, in which case transfers from rich to developing countries enhance growth, reduce emissions and allow an earlier introduction of domestic purchases of backstop technologies. This scenario would raise Africa`s GDP by up to 6% (compared to BAU).

References

Anderson, K., W. Anderson, W. Martin and D. van der Mensbrugghe (2006), *Global Impacts of the Doha scenarios on poverty*, in T.Hertel and A. Winters (2006), Poverty and the WTO, Palgrave.

Cantore, N., Padilla E., *'Equality and CO2 emissions distribution in climate change integrated assessment modelling', forthcoming in Energy – The International Jou*rnal. doi:10.1016/j.energy.2009.09.022

Cantore, N. and D.W. te Velde (2009), *'Promoting energy efficiency in developing countries – new evidence based on firms analysis'*, paper for the UNIDO Report on energy efficiency 2010.

Cantore N. (2009), 'The relevance of climate change integrated assessment models in the design of policies', forthcoming ODI background paper.

Climate Group (2009) Cutting the costs. The economic benefits of collaborative climate action. Available online at http://www.theclimategroup.org/assets/resources/Cutting_the_Cost__BTCD_Report.pdf

Dervis, K. and Jones, A (2009) Overcoming sticking points at COP15, Recommendations from the 2009 Brookings Roundtable.

Garnaut R. (2008), 'Garnaut climate change review', Cambridge University Press.

Goltz, J. (2009) High stakes in a complex game: a snapshot of the Climate Change Negotiating Positions of Major Developing country emitters, Working paper no. 177, Centre for Global Development.

LCA negotiation text Final Version - 8 April 2009, available on line at the web site http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/african_group_submission_lca_april_2009.pdf

Nordhaus W. (1999), 'Roll the DICE again: the economics of global warming', available on line at the web site http://www.econ.yale.edu/~nordhaus/homepage/rice98%20pap%20121898.PDF

Nordhaus, W. and Boyer, J. (2000) 'Roll the DICE again: economic models of global warming', MIT Press, Cambridge, Massachusetts.

Stern, N., 2007, 'Stern Review on The Economics of Climate Change'. HM Treasury, London: http://www.hm-treasury.gov.uk/sternreview_index.htm

World Bank (2010), World Development Report 2010, World Bank, Washington.

Appendix A: The Rice 98 model (RICE98)

RICE98 (Nordhaus, 1999) is an optimal growth model (Ramsey – Solow – Koopmans) that is based on 13 regions (USA, Japan, Other High Income Countries (OHI), Europe, OPEC (HIO), Russia, Eastern Europe Countries, Middle Income Countries, Low Middle Income Countries, Low-income Countries, China, India and Africa). In this quick note we will mainly focus on Africa, Low-income Countries (including poor Asian countries, but excluding African countries), China and India. In the RICE98 model the aggregated regions with the lowest level of income per capita are Low-income Countries, China, India and Africa regions representing the focus of our policy discussion. Regions are not organised according to geographical but income criteria.

Each region maximizes a utility function depending on consumption subject to economic and environmental constraints expressed by appropriate mathematical equations.

A relevant constraint in the production function is represented by the technology that each region can use to produce output. Output is then used by each region to satisfy domestic consumption and investments that are used by each region to guarantee a long run growth path.

- Some inputs (capital, dirty source of energy and backstop technology) are efficiently chosen by each social planner to maximize consumption. Labour is an exogenous variable.

The carbon sources of energy and the backstop technology are perfect substitutes and they have the same productivity, but the green source of energy is more expensive and there are some market penetration constraints.

In the long-run output is affected by global warming damages. There are different regions and groups of countries as follows:

- the Other High Income Countries group includes countries including such as Canada, Australia, New Zealand and others.
- the Middle Income countries group includes countries including South Korea, Brazil, Argentina, Malaysia, Seychelles and others.
- the Low Middle Income Countries group includes Mexico, South Africa, Iran, Venezuela, Turkey, Mauritius and others.
- the Low-income Countries group includes countries such as Iran, Indonesia, Pakistan, Egypt, Viet Nam, Bolivia and others (but not sub-Saharan African countries),
- the Africa group includes sub-Saharan African countries (excluding Mauritius, Seychelles, South Africa)

Full listing available at:
http://www.econ.yale.edu/~nordhaus/homepage/rice98%20tables%20121898.PDF

Annex B: Climate finance scenarios

The EC blueprint points out that climate finance for mitigation and adaptation for developing countries is in the range of € 10 – 20 billion for mitigation and € 10 – 24 billion for adaptation per year. The RICE98 model contains values expressed in 1990 $.

To implement our climate finance scenarios we implement the following steps:

1. We assume central values within the range for mitigation and adaptation climate finance (specifically 15 billion for mitigation and 17 billion for adaptation)

2. We consider an average exchange rate $/€ in 2005 (1.243 $/ 1 €) and we obtain 21.135 and 18.648 2005 $ respectively for finance adaptation and mitigation.

3. As final step we transform 2005 $ in 1990 $ by assuming a CPI deflator (1.49) and we obtain 15 and 13 1990 $ for adaptation and adaptation

The World Development Report climate finance financing needs are expressed in 2005 $. In this case we consider the range 264 – 563 billion for mitigation and 15 – 100 billion for adaptation per year. We calculate the central value within this range and then we assume that 30% of those values are funded by international public finance (the EC blueprint indicates a range 20% - 40%). We obtain 125 billion of 2005 $ for mitigation and 18 billion of 2005 $ for adaptation. Then we apply the CPI deflator to obtain 83 billion of 1990 $ for mitigation and 12 billion of 1990 $ for adaptation. Next tables summarize the estimates for climate financing of developing countries according to the EC blueprint and the WDR (2010).

Table 12: International public finance need for developing countries, EC_blueprint scenario

Description	Public financing need for developing countries by 2020
Mitigation	10 – 20 billion of 2005 € per year
Adaptation	10 – 24 billion of €

Source: EC blueprint (2009)

Table 13: International public finance need for developing countries, WB scenario

Description	Public finance need for developing countries by 2030
Mitigation	
Mc Kinsey model	384 billion of 2005 $ per year
REMIND model	563 billion of 2005 $ per year
MESSAGE model	264 billion of 2005 $ per year
Adaptation	
UNFCCC	28 – 67 billion of 2005 $ per year
Project catalyst	15 – 37 billion of 2005 $ per year
World Bank	75 – 100 billion of 2005 $ per year

Source: WDR (2010)

Both mitigation costs and associated financing requirements indicated by the WDR are incremental relative to a business-as usual baseline. Estimates are for a stabilisation of greenhouse gases at 450 ppm CO_2e, which would provide a 40–50 % chance of staying below 2°C warming by 2100. In our climate finance scenarios run with the RICE98 model results show that the temperature increase relative to 1900 levels within 2100 is below 2 degrees C levels and consistent with a temperature increase of around 1.5 degrees C levels.

Finally in the climate finance scenario mitigation costs are spent in developing countries to purchase a backstop technology. In the RICE98 model the price of a backstop technology is $300 1990 per ton carbon + a regional mark up. This is equivalent to 300 billion of 1990 $ per Gigaton carbon + the mark up. The amount of backstop technology purchased every year by each developing country through international transfers is obtained by the ratio between the amount of transfers and the regional price of the backstop technology.

Table 14: Annual purchase of backstop technology for Africa and low-income countries through international public finance. EC_blueprint scenario

	Annual transfer (billion of 1990 $)	Technology price (billion of 1990 $ per gigaton)	Annual purchase (Gigatons)
LI	4.3	375	0.011
China		327	
India		397	
Africa	8.7	531	0.016
Total	13		0.027

Table 15: Annual purchase of backstop technology for developing countries through international public finance. WB scenario

	Annual transfer (billion of 1990 $)	Technology price (billion of 1990 $ per gigaton)	Annual purchase (Gigatons)
LI	15.8	375	0.042
China	14.2	327	0.043
India	20.7	397	0.052
Africa	32.3	531	0.060
Total	83		0.197

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