Sky Shares

Modelling the distributive and economic implications of a future global emissions budget

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Summary

2015 will be a crucial year for sustainable development, on two counts. First, it will see the COP21 climate change summit in Paris – a key moment in global efforts on climate change, at a point when the window of opportunity for limiting global average warming to 2 degrees Celsius is closing rapidly.

September 2015, meanwhile, will see the definition of new global Sustainable Development Goals to take over from the Millennium Development Goals. While the shape of the Goals is already clear, it remains to be seen whether governments can summon the political will to agree a delivery framework of equivalently high ambition – above all on financing the new goals (itself the subject of a key summit in Addis Ababa in July 2015).

In this paper, we explore the potential for an approach that could potentially offer a breakthrough on both fronts – based on defining a safe global emissions budget as the centrepiece of a global framework for stabilising the climate, and then allocating it between countries on the basis of convergence to equal per capita entitlements by an agreed date (with countries' emission allowances in proportion to their populations from then on).

In particular, we set out findings from a detailed quantitative model that we have constructed, called Sky Shares, which calculates both

- what countries' emission allocations would be, under user-defined parameters, and
- what their net costs would be, including both decarbonisation costs at home, and financial flows through international emissions trading if the user enables trading to be used. (The model automatically calculates each country's optimal mixture of the two for cost-effectiveness.)

Reference Scenario headline findings

Our headline finding is that an approach based on fair shares of a finite carbon budget is both surprisingly affordable for higher emitting countries, and potentially game-changing as a source of finance for development for lower income countries if emissions trading is permitted (something that higher emitting countries also have every incentive to push for, given that it substantially reduces their costs of compliance).

In our Reference Scenario (a 2° Celsius emissions budget, with early mitigation, and convergence to equal per capita allocations by 2030), we find that high income countries as a group would face net costs of only 0.56% of GDP a year in 2025 and 1.45% in 2030, rising to 2.97% by 2050. The United States would face net costs of 0.73% of GDP a year in 2025, and the European Union 0.30%.

Among emerging economies, China would face net costs of 1.37% of GDP a year in 2025, and Russia 1.59% - in both cases, higher than the equivalent figure for the United States. (This raises important issues about equity and fairness, which are discussed below.)

On the other hand, lower emitting emerging economies would be net beneficiaries of the framework in early decades: India would gain 2.63% of GDP a year in 2025 and Brazil 0.50%, though they would then face net costs rather than benefits from around 2045 onwards.

Low income countries (LICs), finally, would stand to gain substantially in our Reference Scenario, given their very low per capita emissions. Ethiopia, for example, would stand to make 27.23% of its GDP a year from emissions trading by 2025, and Bangladesh 9.53%; low income countries as a group would gain 6.39% in 2025.

In dollar terms, the net financial flows to lower middle income countries would amount to $266.8 billion in 2025 (approximately twice as much as the $134.8 billion of *total* global Official Development Assistance flows in 2013), while those to LICs would total approximately $152 billion. This would therefore represent a major new source of finance for development and for delivering the Sustainable Development Goals.

Historical Responsibility Scenario findings

The paper also sets out a Historical Responsibility Scenario for comparison purposes. This is based on the same mitigation parameters as the Reference Scenario, and likewise based on convergence to equal per capita entitlements. Unlike the Reference Scenario, however, this version converges to equal per capita shares of *stocks* of atmospheric carbon – in other words taking account of past emissions as well as current ones, going back to 1800, and then adapting future allowances correspondingly.

Overall, this has the effect of reducing upper middle income countries' costs and increasing those of developed countries. Under the Historical Responsibility Scenario, we find that:

- Upper middle income countries' net costs are 0.63% of GDP in 2025 and 3.32% in 2050 – as compared to 0.75% and 4.23% respectively in the Reference Scenario.

- High income countries' net costs are 1.46% of GDP in 2025 and 5.87% in 2050 – as compared to 0.56% and 2.97% respectively in the Reference Scenario.

China is an outlier in the Historical Responsibility Scenario in that while its costs become *proportionately* cheaper than those of the US in both 2025 and 2050, they rise in *absolute* terms in the earlier years of the framework. Under the Historical Responsibility Scenario,

- China's net costs are 1.44% of GDP in 2025 and 4.20% in 2050 – as compared to 1.37% and 5.22% respectively in the Reference Scenario.

- The United States's net costs are 1.87% of GDP in 2025 and 7.07% in 2050 – as compared to 0.73% and 3.35% respectively in the Reference Scenario.

Our model is available online both to explore other alternative scenarios – including ones based on a specified 'coalition of the willing' rather than assuming full global participation at the outset – and for adaptation of the source code, which is open source and freely available.

1. Introduction: one year, two agendas

Climate change

The world is approaching the point at which it needs to start to get serious about international action to address climate change. The UN climate change process has now been underway for nearly a quarter of a century since the UN Framework Convention on Climate Change (UNFCCC) was signed in 1992. Over that period, global CO_2 emissions have risen by 52%.[1]

Researchers at Oxford University have calculated that the world can emit no more than 750 billion tonnes of carbon in total in order to have a less than 25% risk of exceeding 2° Celsius of global average warming.[2] The world has already emitted more than 500 billion tonnes of this 'emissions budget' since the mid-18th century, leaving it only 250 billion tonnes remaining – which, on current rates, are likely to be used up within the next two decades.[3]

As governments approach the 2015 COP21 climate summit in Paris, then, there are strong scientific reasons for them to consider basing international climate policy on a global carbon budget, designed to keep the world below the 2° threshold, and which would be allocated between all 195 of the world's countries.

The idea of emissions budgets is already embedded in some national contexts – most notably the United Kingdom, where the 2008 Climate Change Act set a long term, legally binding emissions reduction target for the UK of at least 80% below 1990 levels by 2050. The Act also created an independent Committee on Climate Change charged with advising the government on emissions targets and reporting to Parliament (and publicly) on progress made towards them.

However, the idea of doing the same at global level has to date made much less headway, with the idea of a global emissions budget often seen as politically impractical by country negotiators – above all because of the charged issues of equity and fairness involved.

On one hand, it is hard to imagine developing countries ever agreeing that a common property resource like the atmosphere should be allocated indefinitely on the basis of 'grandfathering', with countries' allocations in proportion to their current emissions. Given that countries' emission levels are themselves usually proportionate to GDP, allocating an emissions budget on this basis would in effect be to create new property rights to a global commons, and then share them out on the basis that the richer a country is, the larger its share should be.

But on the other hand, many developed country negotiators have to date assumed that an allocation of emissions quotas on an equal per capita basis would be ruinously expensive for them, and as a result politically unsellable to their electorates.

While proposals have been advanced as ways of bridging this gap – most notably, the idea of a managed process of *convergence* to equal per capita rights over a negotiated period that could be

[1] Source: http://edgar.jrc.ec.europa.eu/news_docs/pbl-2013-trends-in-global-co2-emissions-2013-report-1148.pdf. Table on pps. 16-17 cites total global CO2 emissions as 22.6 billion tonnes in 1992, and 34.5 billion tonnes in 2012.
[2] http://www.newscientist.com/article/dn17051-humanitys-carbon-budget-set-at-one-trillion-tonnes.html#.VIgwhTGUd8E
[3] ibid

decades long, first proposed by the Global Commons Institute[4] – these have not to date achieved a major breakthrough in the UNFCCC negotiations.

The idea of a global emissions budget has hence remained off the table for most of the history of the UN climate process, despite the fact that the need for such an approach could readily be seen as implied in Article 2 of the UNFCCC, which defines the overall objective of the Convention as "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".[5]

Instead, the need for an equitable approach – defined in the Convention in terms of countries' "common but differentiated responsibilities and respective capabilities"[6] – has to date been interpreted as implying a sub-global approach in which only some countries would have quantified, binding emission targets.

Under the 1997 Kyoto Protocol, quantified targets were limited to developed countries only (with the US among the countries that declined to participate as a result, arguing that a global approach to climate change could only work if major developing country emitters had targets too). Subsequently, in 2009, the Copenhagen summit agreed a voluntary approach based on non-binding targets, known as 'pledge and review', at the behest of the US and major emerging economies.

However, the result of this approach, according to the International Energy Agency in its 2013 *World Energy Outlook*, has been to put the world on course not for limiting global average warming to 2°, but instead for long term warming of 3.6 – 5.3°, with most of this warming likely to occur before the end of the 21st century.[7]

In this light, the need for a global emissions budget does not appear to have receded. Significantly, the last few months have seen some 'weak signals' that the issue may finally be starting to come on to the formal agenda. In November 2014, a 'non-paper' tabled by the UN climate secretariat mooted the possibility of "a global carbon budget to be divided amongst Parties in accordance with historical responsibilities, ecological footprint, capabilities, and state of development".[8]

More recently, in February 2015, an 86 page draft negotiating text for Paris – compiled on the basis of all Parties being able to submit whatever text they wished for discussion in later negotiating rounds in the run up to Paris – also included multiple mentions of the idea of a "global emission budget to be divided among all Parties".[9]

Against this backdrop, then, a key question for the future of the UN climate process – and for prospects for limiting global average warming to 2° Celsius – is how such an emissions budget might be shared out, and what the financial implications for individual countries might be.

Meanwhile, the vexed issue of climate finance also continues to be a major focus of the negotiations. Overall, around $331 billion a year of climate finance is flowing within, to, and

[4] Aubrey Meyer (2001). *Contraction and Convergence: The Global Solution to Climate Change*. Green Books.
[5] http://unfccc.int/resource/docs/convkp/conveng.pdf Article 2
[6] Ibid Article 3
[7] http://www.iea.org/media/freepublications/executivesummary/WEO2013_Climate_Excerpt_ES_WEB.pdf
[8] http://unfccc.int/resource/docs/2014/adp2/eng/11nonpap.pdf
[9] http://unfccc.int/files/bodies/awg/application/pdf/negotiating_text_12022015@2200.pdf

between countries, with nearly 60% from private investment.[10] However, this is less than half the estimated total needed, and access to climate finance is especially challenging for Least Developed Countries. Around 80% of Certified Emissions Reductions generated through the Clean Development Mechanism, an emissions trading mechanism under the Kyoto Protocol, went to just four countries, for example: India, China, Brazil, and Mexico.[11]

Now, with COP21 in prospect, many LDCs are hoping that they will benefit from the Green Climate Fund, a UNFCCC mechanism that is supposed to raise $100 billion a year by 2020. But arguments remain unresolved over what proportion of this amount will come from public and private sources respectively, and as at the end of 2014 only around a tenth of the headline figure had been pledged by developed country governments.[12]

In the next section but one, we set out some findings that we hope will inform the debates over options for stabilising the climate and increasing flows of climate finance. First, though, we examine another key multilateral process due to come to a head in 2015.

Financing the Sustainable Development Goals

2015 is also significant as a key milestone year for international development. The Millennium Development Goals (MDGs) expire at the end of 2015, and governments are due to agree their successors – likely to be called Sustainable Development Goals (SDGs) – at a summit in New York in September 2015.

At the time of writing, the likely shape of the new SDGs is already clear, following the report of a UN-mandated intergovernmental 'Open Working Group' (OWG) on the agenda.[13] The OWG's report sets out proposals for a 17 Goal framework that includes a mixture of Goals that aim to finish what the MDGs began – most notably in SDG 1's ambition to eradicate absolute poverty altogether by 2030 – and Goals in wider areas, including climate change, sustainability, and inequality within and between countries.

However, while the content of the new SDG framework appears clear, less progress has been made on agreeing a global delivery framework for achieving the new Goals ('means of implementation' in the process's jargon). In particular, preparations for a major summit on financing for development (FFD), due to be held in Addis Ababa in July 2015, appear hallmarked by a lack of political will among higher income countries to agree on ambitious new action plans.

In part, this reflects momentous changes in the development agenda since the MDGs were agreed. Many developing countries are now increasingly able to finance their own development: total developing country tax revenue has increased from $1.5 trillion a year in 2000 to $7 trillion in 2011, for example.[14] Developing countries are also likely to account for 62-64% of global savings by 2030, up from 45% in 2010.[15]

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[10] http://www.worldbank.org/en/news/feature/2014/09/05/climate-finance-is-flowing-but-not-enough-yet
[11] http://www.cdmpipeline.org/cdm-projects-region.htm
[12] http://news.gcfund.org/wp-content/uploads/2015/02/pledges_GCF_dec14.pdf
[13] https://sustainabledevelopment.un.org/owg.html
[14] Greenhill, R., and Prizzon, A. (2012). *Who Foots the Bill? What new trends in development finance mean for the post-MDGs*. ODI Working Paper 360. London: Overseas Development Institute.
[15] World Bank (2013). *Capital for the Future: Saving and Investment in an Interdependent World*. Global Development Horizons report. Washington DC: World Bank.

Meanwhile, private sector flows to developing countries have also become far more significant than aid flows as a source of finance for development. In 2010, foreign direct investment (FDI) to developing countries was worth $514.3 billion, migrant worker remittances $325.3 billion, and portfolio equity flows $129.7 billion – as compared to Official Development Assistance (ODA) flows of $128.7 billion in the same year (0.32% of donor countries' gross national income).

But not all developing countries have benefited equally from these shifts. The key beneficiaries of higher FDI and domestic resource mobilisation have been middle income countries (MICs), especially those at the higher end of the bracket. So while aid accounts for just 0.3% of the average MIC's GDP, it still accounts for 9.7% of that of the average low income country (LIC).[16]

Yet while least developed countries (LDCs) remain disproportionately reliant on ODA compared to developing countries as a whole, they are also receiving a steadily diminishing share of it, with the OECD Development Assistance Committee (DAC) warning of a "worrying trend of declines in programmed aid to LDCs and low income countries, in particular in Africa".[17]

As a result, the post-2015 development agenda has seen growing calls for LDCs to receive a larger share of global ODA – whether through developed countries making good on their long standing promise to allocate at least 0.15% of gross national income to ODA in LDCs, or in more recent proposals for at least 50% of total ODA to go to LDCs.[18]

However, prospects for a major breakthrough on this area at the Addis financing summit currently look limited, with few donor countries feeling real political pressure to raise the proportion of their aid spent on LDCs. There is therefore a significant risk that Addis could end in disappointment for LDCs – matching the risk of a similar outcome on climate finance in Paris.

Cascading failure or creative synergy?

While 2015 offers a major opportunity to achieve breakthroughs on both climate change and international development, it also presents real risks. As this section has discussed, both agendas have hugely challenging ambitions, whether limiting long term global average warming to 2°C, or eradicating absolute poverty by 2030. Yet both agendas could also fall prey to much lower ambitions when it comes to delivery.

This creates two risks. First and most obviously, that the world will simply fail to achieve its stated aims on climate change and development. While governments in both processes appear to believe that their best option may be to aim to play a long game and ratchet up ambition on delivery over the 2-3 years following 2015, this approach is fraught with danger. 2015 is, after all, a key 'moment in the sun' for each agenda; the political context will only get more difficult as other issues and priorities make their way on to the global agenda.

Second, there is the risk that disappointment or acrimony in one process will negatively affect the other. If, for example, the Addis FFD summit fails to live up to the high expectations that many developing country governments have for it, then this could poison the atmosphere in the lead up to

[16] Greenhill, R., and Prizzon, A. (2012). *Who Foots the Bill? What new trends in development finance mean for the post-MDGs*. ODI Working Paper 360. London: Overseas Development Institute.
[17] http://www.oecd.org/newsroom/aid-to-developing-countries-rebounds-in-2013-to-reach-an-all-time-high.htm
[18] See for example http://oecdinsights.org/2014/07/21/half-of-all-oda-should-go-to-the-least-developed-countries/

New York and Paris. Similarly, if preparatory climate talks in Bonn in June go awry then this could pose challenges for the political mood on SDGs and Financing for Development. There is a real risk of a cascading failure that spills across multiple multilateral processes.

But it is also possible that 2015 could see the opposite dynamic, with progress on one agenda unlocking momentum and room for manoeuvre on the other, and vice versa – in particular if potential synergies between the two agendas can be identified and maximised.

As we set out in the next section, we believe that just such a synergy exists in the combination of a safe global emissions budget as a means of stabilising greenhouse gas concentrations, combined with equitable shares of that budget as a means not only of securing agreement on its allocation but also, in the process, driving a major new finance for development flow.

2. Sharing the sky

Many climate negotiators have long believed that however desirable discussion of a global emissions budget as a way of stabilising atmospheric greenhouse gas concentrations might be in principle, the idea is a political non-starter.

This belief has in turn been often based on an assumption that prospects for agreement on how to share such an emissions budget look bad given the risk that such a discussion would become a purely zero sum game – in which the political dynamics focused in almost exclusively on the fact that a larger share for developing countries would imply a smaller share for developed countries, and vice versa.

We wanted to put this assumption to the test by putting some concrete numbers on possible scenarios, and exploring the potential for emissions trading to drive win-wins for countries in all income groups. To do this, we built a detailed quantitative model, which we called SkyShares.

The model is designed not only to explore potential ways of allocating a global emissions budget between 195 countries, but also to investigate what the financial implications would be on a country-by-country basis – including both the costs of decarbonisation at home, and the financial flows through international emissions trading between countries if this is included as part of the framework.

Design principles

In overview, our approach to constructing the model was as follows (a detailed technical paper is also available at [link to be inserted following review].

First, we created the capacity for the user to define a global emissions mitigation scenario. The most important variable here is the size of the carbon budget, which is defined by the desired maximum amount of global average warming, and by how cautious or optimistic the user decides to be about atmospheric variables. (As noted earlier, a 750 billion tonne emissions budget includes a 25% chance of overshooting 2°C of global warming; a 1 trillion tonne emissions budget, on the other hand, would increase that risk to 50%).[19]

The other key variable in determining the mitigation scenario is how soon mitigation activity begins in earnest under the agreed framework: waiting until 2020 rather than commencing mitigation activity on 1 January 2016, for example, makes a highly significant difference to the size of the emissions budget in later years and decades.

Second, we built in functionality for the user to define how the emissions budget should be allocated between countries. Three allocation algorithms are available in the model:

- Permits are 'grandfathered' (i.e. in proportion to countries' GDP) on an indefinite basis.

- Permits are allocated on the basis of equal per capita shares of each year's emissions budget (i.e. in proportion to population) – either as soon as the framework starts to operate, or at

[19] http://www.newscientist.com/article/dn17051-humanitys-carbon-budget-set-at-one-trillion-tonnes.html#.VOsVU_mUd8E

the end of a defined convergence period (this is the 'contraction and convergence' approach first proposed by the Global Commons Institute[20]).

- Permits are allocated on the basis of equal per capita shares of the *total* emissions budget from 1800 to 2100 (in other words, adjusted so that countries that emitted more in the past receive correspondingly fewer allowances in the future).

The allocation function also allows the user to select either a scenario in which the whole world participates in the framework, or any subset of countries – thereby allowing users to model potential 'coalitions of the willing'.[21]

Third, we built in capacity to model both net costs and international financial flows. Any country with actual emissions set to overshoot their allocated quota would have two options. One is to introduce decarbonisation policies in the domestic context that are sufficient to bring their emissions down to within their quota.

The other, if international emissions trading is permitted in the framework, is to purchase the required emission permits from another country whose actual emissions total less than their allocated quota. (The model allows the user either to allow unrestricted emissions trading; or to disallow it altogether; or to stipulate that countries may use it only up to a defined cap.)

Assuming that emissions trading is permitted, we designed the model automatically to calculate the optimal combination of domestic decarbonisation and international emissions trading for cost effectiveness. (Higher emitting countries only purchase emissions trading permits from abroad when this is cheaper than undertaking the equivalent decarbonisation at home, in other words.)

Finally, we needed to make some assumptions about emission abatement costs. We did this by incorporating within the model emission cost curve data from the Massachusetts Institute of Technology dataset, which are widely regarded as some of the most authoritative data available on this area.[22]

Defining a Reference Scenario and Historical Responsibility Scenario

For our illustrative Reference Scenario findings, we assumed a framework designed to **limit global average warming to 2° C**, with **mitigation activity beginning immediately** upon agreement of the framework.

The scenario assumes that **all countries participate** from the outset, and that **allocations of the global emissions budget converge from being in proportion to current emissions to start with, to equal per capita entitlements in the year 2030**. Our rationale here was that, while there is no one obviously intuitive way of sharing out the *burden* of mitigating emissions between countries, this changes when the question is how to share out property rights that are part of a *global emissions budget*.

[20] Aubrey Meyer (2001). *Contraction and Convergence: The Global Solution to Climate Change*. Green Books.
[21] Our assumption here is that participating countries would receive exactly the same allocation as they would have under full global participation. The door would be left open for other countries to join in future, in each case taking on the same entitlement, for that year onwards, that they would have received had they joined from the outset. However, late entrants would of course forfeit the opportunity to be part of the initial negotiation about the size of the emissions budget and date of convergence.
[22] Reference for MIT dataset

We reasoned here that the atmosphere is, after all, the quintessential example of a shared commons. At the point when climate mitigation requirements make it necessary to share out allocations to this resource, and new property rights within it are created, we believe that it makes intuitive sense that all people should enjoy the same share.

At the same time, the inclusion of a managed convergence period is intended to recognise the fact that time will be needed for countries to adjust from the current levels of countries' emissions (which are broadly proportionate to countries' GDP) to a new allocation of entitlements proportionate instead to population. We selected 2030 as a middle of the road date; the effect of bringing this date forward, or pushing it back later, is discussed later.

However, we also recognised that many developing countries will point to the issue of historical responsibility for past emissions as an important factor to take into consideration, including in how an emissions budget is shared out. The basis for these claims rests on the fact that many greenhouse gases have considerable longevity in the air, to the extent that emissions from Great Britain in the early years of the industrial revolution are still present in the atmosphere, exerting radiative forcing effects and contributing to climate change.

In recognition of this argument, we included in the model capacity for permits to be allocated on the basis of equal per capita shares of the *total* emissions budget from 1800 to 2100 – and we use this as the basis of a Historical Responsibility Scenario to complement the Reference Scenario. (All other variables are held constant across the two scenarios.)

Finally, both scenarios permit **unrestricted emissions trading** between countries and assume that countries use this option where doing so is more cost-effective than undertaking the equivalent decarbonisation at home. They also each assume a **0% discount rate**, which affects the model's findings by increasing the costs for high emitters in later years, and hence accounts for the fact that costs can appear high for some countries after 2050.

Reference Scenario findings

Given the parameters just set out, our key findings were as follows.

First, an approach based on equal per capita shares of a cautious 2° emissions budget is surprisingly affordable. In 2025, for example, the net cost of mitigation to keep within the global emissions budget comes to 0.13% of global GDP in that year. While costs do then rise in later decades, they never exceed 5% of global GDP, instead peaking at 4.97% of global GDP in 2080.

Costs are also relatively low for high income countries. In 2025, net costs for high income countries as a group come to 0.56% of their GDP, rising to 1.91% in 2035. Costs do then rise in later decades, but always remain well below 5% of GDP, peaking at 3.56% of GDP in 2075.

- The United States's net costs are 0.73% of GDP in 2025, 2.38% in 2035, and 3.28% in 2075.

- The equivalent figures for the European Union are significantly lower in both the near and long term: 0.30% in 2025, 1.02% in 2035, and 3.05% in 2075.

- Russia faces proportionately higher costs than many other high income countries, at 1.59% in 2025, 5.25% in 2035, and 6.67% in 2075.

Costs are also affordable for middle income countries – although for upper middle income countries (UMICs), higher than those of high income countries as a proportion of GDP, a finding that is both counter-intuitive, and at odds with the principle of historical responsibility for past emissions. For upper middle income countries as a group, costs are 0.75% of GDP in 2025, rising to 2.88% of GDP in 2035, and 5.62% in 2075.

- China's costs are significantly higher still than for those of UMICs as a group, at 1.37% of GDP in 2025, 4.40% in 2035, and 5.65% in 2075.

- Brazil, on the other hand, is a net beneficiary in the early years, making 0.50% of its GDP from emissions trading in 2025 and 0.71% in 2035, although it then faces net costs of 1.42% of GDP in 2050 and 2.79% in 2075.

Lower middle income countries (LMICs) are strong net beneficiaries in the early years of the framework as a result of their capacity to sell spare emissions permits through emissions trading: they gain 2.91% of GDP in 2025 and 4.23% in 2035. By 2050, however, they incur net costs of 1.89% of GDP, rising to 8.44% in 2075. Among LMICs,

- India gains 2.63% of GDP in 2025 and 2.56% in 2035, but then faces a net cost of 4.51% in 2050 and 9.59% in 2050.

- Nigeria gains 7.15% of GDP in 2025, 15.34% in 2035, and 8.86 % in 2050; it faces a net cost for the first time only in 2075.

- Indonesia gains 0.60% in 2025 but already faces a net cost of 2.28% of GDP by 2035, rising to 15.54% in 2050 and as much as 25.03% in 2075.

In dollar terms, net financial flows to LMICs amount to $266.8 billion in 2025 (approximately twice as much as the $134.8 billion of *total* global Official Development Assistance flows in 2013)[23], and $849.8 billion in 2035. These inflows are particularly significant in view of the 'financing gap' faced by many LMICs, who find after they have graduated from LIC status that they are no longer eligible for many concessional aid flows, but not yet benefiting from foreign direct investment on the scale of UMICs nor as able to mobilise domestic resources through tax revenue.[24]

Low income countries, as the lowest per capita emitters, are the biggest beneficiaries of the framework – which in effect creates a major new source of finance for development. As a group, LICs gain 6.39% of GDP from emissions trading in 2025, 13.93% in 2035, and 8.17% in 2050. In dollar terms, this means that LICs stand to gain approximately $152 billion a year by 2025.

- Ethiopia gains 27.23% of GDP in 2025, rising to 54.36% by 2035. In dollar terms, it would stand to make $17 billion in 2025, and $62 billion by 2035.

[23] http://www.oecd.org/newsroom/aid-to-developing-countries-rebounds-in-2013-to-reach-an-all-time-high.htm
[24] See Homi Kharas, Annalisa Prizzon and Andrew Rogerson (2015), *Financing the post-2015 Sustainable Development Goals: A rough roadmap*, London: Overseas Development Institute

- Bangladesh gains 9.53% of GDP in 2025 and 16.96% in 2035, which equates to inflows of $21.3 billion in 2025 and $66.8 billion a decade later.

The net flows of money to LICs and LMICs are large sums of money, then, that would potentially be game-changing both for individual LICs, and at global scale for prospects for achieving the Sustainable Development Goals that the world is about to agree.

But it is also worth reiterating that *each dollar spent by higher emitting countries on buying emissions permits from LICs is also a dollar that saves these higher emitting countries money* – because, as noted earlier, our model only assumes that emissions trades take place where doing so is cheaper for the purchasing country than undertaking the equivalent emissions reductions at home.

Table 1: Net benefit / cost as % of GDP for different income groups under Reference Scenario

	2025	**2035**	**2050**	**2075**
Low income countries	+6.39%	+13.93%	+8.17%	+0.35%
Lower middle income countries	+2.91%	+4.23%	-1.89%	-8.44%
Upper middle income countries	-0.75%	-2.88%	-4.23%	-5.62%
High income countries	-0.56%	-1.91%	-2.97%	-3.56%
World	-0.13%	-1.04%	-2.76%	-4.89%

Historical Responsibility Scenario findings

As noted in the last section, one counter-intuitive finding of the Reference Scenario is that upper middle income countries face proportionately higher costs that high income countries. We therefore outline here an alternative scenario for comparison, which is still based on convergence to equal per capita shares and the same overall mitigation parameters.

Where this Historical Responsibility Scenario is different, however, is that countries are allocated equal per capita shares of the total *stock* of the carbon budget over time – so that countries that emitted more in the past receive correspondingly lower allocations in the future. (Under the Reference Scenario, by contrast, once convergence to equal per capita shares has taken place it is *each year's* emissions budget that is shared equally.)

The headline findings for each income group under the Historical Responsibility Scenario (HRS) are summarised in Table 2 below, with the equivalent Reference Scenario (RS) figures shown alongside for comparison.

Table 2: Net benefit / cost as % of GDP for income groups under Historical Responsibility Scenario

	2025		**2035**		**2050**		**2075**	
	HRS	*RS*	**HRS**	*RS*	**HRS**	*RS*	**HRS**	*RS*
LICs	**+12.89%**	*+6.39%*	**+20.48%**	*+13.93%*	**+14.94%**	*+8.17%*	**+6.90%**	*+0.35%*
LMICs	**+7.21%**	*+2.91%*	**+9.22%**	*+4.23%*	**+3.61%**	*-1.89%*	**-2.48%**	*-8.44%*
UMICs	**-0.63%**	*-0.75%*	**-2.16%**	*-2.88%*	**-3.32%**	*-4.23%*	**-4.37%**	*-5.62%*
HICs	**-1.46%**	*-0.56%*	**-3.62%**	*-1.91%*	**-5.87%**	*-2.97%*	**-7.56%**	*-3.56%*
World	**-0.13%**	*-0.13%*	**-1.04%**	*-1.04%*	**-2.76%**	*-2.76%*	**-4.89%**	*-4.89%*

As would be expected, **the lowest emitters – LICs and LMICs – are substantially better off under a historical responsibility allocation**. LICs as a group benefit from financial inflows of some $304.5 billion by 2025 (compared to $152 billion in the Reference Scenario), while LMICs see inflows of $626.9 billion in the same year (compared to $266.8 billion in the Reference Scenario).

Upper middle income countries also face lower costs than under the Reference Scenario – although as a group, they still face net costs rather than benefits more or less as soon as the framework is up and running. As Table 2 shows, however, the differences in UMICs' net costs as a proportion of GDP between the Reference Scenario and the Historical Responsibility Scenario are not dramatic (with less than 1% of GDP difference between the two until well after 2050).

High income countries' costs rise substantially under the Historical Responsibility Scenario, and are higher than those of UMICs in every decade to 2100 – unlike in the Reference Scenario. However, their costs as a group are still only 1.46% of GDP in 2025 and 3.62% in 2035, though they later rise to 5.87% in 2050 and 7.56% in 2075.

For the world as a whole, the total costs remain unchanged across the two scenarios – the result that would be expected, given that the model automatically optimises domestic action versus emissions trading for maximum cost-effectiveness (unless the user restricts or disallows trading as a scenario parameter).

3. Conclusions

A moment of potential crisis or opportunity

The world's window of opportunity to limit global average warming to 2° Celsius is closing rapidly, but the world seems little closer to recognising up to what it will take to stabilise greenhouse gas concentrations at a safe level – a global emissions budget – than it was when the UN Climate Convention was agreed in 1992.

At the same time, policymakers are about to agree a Sustainable Development Framework of breathtaking ambition – but without so far showing much sign of willingness to be as ambitious when it comes to delivery, and above all financing.

At a point when mistrust and or acrimony risk becoming standing features of both sets of negotiations, there is a real risk that 2015 will see a breakdown of efforts to marshal collective action on both of these crucial global issues. But there is also the possibility that 2015 will live up to its billing, and mark an historic breakthrough on both of these intimately linked agendas.

This paper has set out a potential way of squaring this circle through a synergy that would both establish the comprehensive framework for solving climate change that the world has long needed, and in doing so create a major new source of finance for development.

Three key principles

The approach outlined in this paper is based on three principles. First, the need to translate scientific assessments more directly into political application, through the mechanism of a single global emissions budget.

The size of the emissions budget could in principle be amended in future to take account of emerging scientific findings. (This raises the question of what kind of process – or institution – might be charged with exercising this review function, but we do not address that in this paper.)

Second, the approach outlined here is based on an assumption that if science dictates that it is necessary to allocate targets within this global emissions budget – targets that are, in effect, atmospheric property rights or 'sky shares' – then common sense dictates that it will be impossible to achieve global agreement on this unless the principle of per capita equity is front and centre.

We do not accept that this would constitute a form of global redistribution, as some might argue. Rather, it would be more accurately described as a form of *pre*-distribution, given that the property rights in question have not yet been created. We would also argue that this is an interpretation of the vexed principle of Common But Differentiated Responsibilities that tends towards, rather than away from, a shared solution to climate change.

As we have seen, the principle of equal per capita entitlements still leaves considerable flexibility – for example through negotiating a delayed period of convergence during which emissions allocations move from current levels to per capita parity, or equal per capita shares of the total *stock* of emissions past, present, and future.

But we struggle to see how the principle of one person, one share of the sky could be excluded altogether and indefinitely from how a global emissions budget is allocated, given that the resource being shared is the most fundamental example of a global commons, and a shared inheritance that manifestly belongs to all of humanity.

Third and finally, the approach outlined here is based on a strong belief in the need for a market-based approach. We believe that a framework based on property rights, on pricing in environmental externalities, and on avoiding situations in which governments attempt to 'pick winners' from among technological options will be superior to one in which these attributes are absent.

Why it makes sense to include emissions trading

On this note, our model also clearly illustrates why it makes economic sense (for *all* countries, rich or poor) to include fully liberalised emissions trading as part of the framework. For lower emitters, emissions trading allows them to profit from the fact that their emissions are low, creating as we have seen a major new source of finance for development. For higher emitters, emissions trading allows commitments to be met flexibly and at least cost (in both of our scenarios in this paper, emissions trading is only assumed to take place where it is cheaper than decarbonising at home).

It is also worth highlighting that the benefits of emissions trading would flow most of all to low income countries, followed by lower middle income countries – in marked contrast to every other main form of finance for development. Low income countries have benefited much less than middle income countries from foreign direct investment and migrant worker remittances; they have less capacity to mobilise development finance from domestic sources; and they are also receiving a declining share of global ODA flows, despite their higher dependence on aid.

In this sense, the financial flows that would result from the scenarios discussed in our paper would be a valuable counterweight to current structural problems in development finance, with a powerful inbuilt poverty focus that results from the fact that the poorest countries are also almost invariably the lowest per capita emitters.

The use of emissions trading in our two scenarios stands in marked contrast to the current 'pledge and review' approach that has been the key idea in global climate policy since the Copenhagen summit in 2009. Under pledge and review, the fact that no provision is made for emissions trading means in effect that national pledges have to be carried out entirely through domestic decarbonisation – despite the additional expense and economic inefficiency entailed as a result.

But the provision for emissions trading in Sky Shares is also very different from the inclusion of emissions trading under the Kyoto Protocol. Under Kyoto, emissions trading was open even to countries that did not have quantified caps on their emissions through the Clean Development Mechanism (CDM) – a form of trading known as 'baseline and credit' (as opposed to 'cap and trade').

In baseline and credit trading, emissions reduction permits are issued to projects such as wind farms or installation of energy efficiency equipment by comparing the *actual* emissions from the project with a counterfactual estimate of what the emissions *would* have been in the absence of the project. This naturally introduces significant uncertainty about whether emissions reductions have genuinely taken place or not – an uncertainty compounded by the fact that various companies supposed to approve project accreditation for the CDM have had to be suspended by the United Nations amid

alleged failures to check projects properly, including the world's largest such CDM accreditor, SGS UK.[25]

However, these problems do not apply to the scenarios outlined in this paper, because:

- All emissions trading envisaged in our scenarios would take place within a single global emissions budget.

- All countries engaged in emissions trading would have quantified, binding ceilings on their emissions; there is no potential for 'carbon leakage'.

- All trading would take place through 'cap and trade' emissions trading rather than 'baseline and credit'. No emissions permits are issued on the basis of hypothetical estimates of what emissions might have been in the absence of a given mitigation project.

A positive sum outcome

Finally, it is worth considering one of the objections sometimes made to proposals based on defining a global emissions budget and then sharing it out between 195 countries: that it would create a 'zero sum' dynamic as countries squabble over shares of a finite resource, and would make no allowance for future advances in technology that would bring down the cost of emissions reductions in future.[26]

We believe this argument to be wrong on two counts.

First, we think it is based on a misapprehension of how to manage shared environmental commons. Back in 1968, Garrett Hardin argued in his famous essay *The Tragedy of the Commons* in 1968[27] that common resources would inevitably lead to overuse and ultimately collapse as individuals rationally maximised their use of the commons. After its publication, he was rightly criticised for failing to allow for the fact that humans could – equally rationally – agree shared management frameworks for commons. Instead, as Nobel economics laureate Elinor Ostrom and others would point out, recognition of the need to cooperate to manage shared commons can be a uniquely powerful driver for *positive* sum dynamics.

Second, we believe that this argument overlooks the fact that it is precisely quantified caps on emissions that are most likely to bring down the costs of clean technology – in effect creating a virtuous circle whereby demand for lower emission technologies reduces their costs and makes them more widely available. Our approach does not merely anticipate future advances in technology; it *prices* them in, and also takes seriously what will be necessary to *drive* those advances.

Above all, we think that the approach set out here is practical, not utopian. A framework based on the principles we have outlined would not depend on full global participation at the outset: on the

[25] http://www.businessgreen.com/bg/news/1806434/updated-carbon-market-un-suspends-british-cdm-project-accreditor
[26] See for example http://www.theguardian.com/environment/2013/oct/24/ipcc-carbon-budget-warsaw-climate-change-christiana-figueres
[27] http://www.sciencemag.org/content/162/3859/1243.full

contrary, it can work with a coalition of the willing, as the Sky Shares model will illustrate for any combination of countries.

While recognising that any comprehensive approach to climate change will involve costs, unrestricted use of emissions trading between participants keeps these costs as low as they can be.

Above all, we believe that the recent disappointing track record of multilateralism and the ongoing leadership deficit points to an unmet need for big ideas about how we can take control of our shared global future. We believe that this is just such an idea.

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