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Triggering the low-carbon transition in the aftermath of the global financial crisis

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An assessment of the post-Kyoto climate change negotiations, and the altered role of climate finance post-financial crisis, is presented. First, the paradigm shift of the Cancun Agreements is examined from an historical perspective and it is shown that the impasse in the negotiations, caused by the underlying over-emphasis on burden sharing reductions in emissions, can be overcome. Second, using information from two modelling exercises, it is demonstrated how climate finance can encourage the decoupling of carbon emissions from economic growth and thereby help align the development pattern with global climate goals. Third, a framework to place carbon finance within current discussions is sketched regarding both the reformation of the world financial systems and the facilitation of a sustainable economic recovery that is beneficial for North and South while addressing the low-carbon transition. It is concluded that upgrading climate finance is the key to triggering the shift to a low-carbon society and a system is proposed in which an agreed social cost of carbon is used to support the establishment of carbon emissions certificates to reorient a significant portion of global savings towards low-carbon investments.

Policy relevance
Investments that align development and climate objectives are shown to substantially lower the social cost of carbon and deliver long-term carbon emissions reductions. These reductions are greater than those contributed by the sole carbon price signal generated by a world cap-and-trade system. Carbon finance, as a part of the broader reform of financial systems and overseas aid, can help overcome the dual adversity of climate and financial crisis contexts. The carbon certificate, with an upfront agreed social cost of carbon, can be used as its instrument. The portion of the banking system that intends to reorient a significant part of world savings towards low-carbon investments could thus issue such carbon certificates. By giving carbon assets the status of a reserve currency, the system could even respond to the need of emerging countries to diversify their foreign exchange reserves and trigger a wave of worldwide sustainable growth through infrastructure markets.

Keywords: Cancun Agreements; climate change negotiations; climate finance; low-carbon transition; social cost of carbon; sustainable development

1. Introduction

The Cancun Agreements called for 'a paradigm shift towards building a low-carbon society that offers substantial opportunities and ensures continued high growth and sustainable development' (UNFCCC, 2011, Decision 1/CP.16, paragraph 10). It established a Green Climate Fund, which will

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be designated as an operating entity of the financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC), and will become accountable to the Conference of the Parties. The Framework is intended to ensure that it will support mitigation efforts in non-Annex I countries and projects under an 'Adaptation Framework'. It confirmed the commitment, made by developed countries at Copenhagen in 2009, to provide 'fast-start finance', an additional US$30 billion of new and additional fast-start finance from 2010 to 2012.

Although climate finance has come to be critical in climate affairs, it now risks triggering a new wave of disappointments. First, the Durban Conference marked the likely absence of a global cap-and-trade system (or of carbon taxes) in the near future.[1] Without a carbon price, the scaling up of climate finance will be limited because of the absence of a reward for reducing carbon emissions. Second, the current financial crisis creates a context in which the governments of most Organisation for Economic Co-operation and Development (OECD) countries face important public deficits and their banking systems are forced to engage in significant deleveraging. However, without an early redirection as part of the world savings towards a low-carbon infrastructure, emerging economies will soon be locked into carbon-intensive development patterns, and developed countries will not refurbish their existing capital stock fast enough.

In this article, the paradigm shift of the Cancun Agreement is viewed from an historical perspective and it is shown how it departs from a 'burden sharing' paradigm. Through the use of two modelling exercises, it is shown how the Cancun Agreement changes the economic assessment of the decoupling between carbon emissions and economic growth and why climate finance is necessary, but not a new silver bullet. Finally, carbon finance is placed in the context of the current discussions about both the reforms of the world financial systems and a sustainable economic recovery that is beneficial for both North and South.

2. Post-Kyoto negotiations: a necessary paradigm shift in an untimely context

The diplomatic momentum that led to the Kyoto Protocol was not a result of an *ex ante* fully fledged vision of a global climate architecture. Although a few such visions were produced (e.g. Agarwal & Narain, 1991; Grubb, 1990), it was, rather, the outcome of a succession of diplomatic *fait accompli* (Bodansky, 2001): *inter alia* the principle of common but differentiated responsibilities (Article 3.1, UNFCCC, 1992), a quantity-based approach to settle countries' commitments that exempted developing countries from such commitments prior to 2012 (Berlin COP 1, 1995), and the possibilities, under Articles 17 and 12 of the Kyoto Protocol, respectively, of carbon trading between countries and of a project-based Clean Development Mechanism (CDM) between developed and developing countries.

This global climate architecture was meant to organize North–South transfers large enough to spur the South to make significant quantitative commitments post-2012. Its key mechanism was a cap-and-trade system and a uniform worldwide carbon price that would both minimize the costs of meeting a global target and prevent distortions in international competition. This led to a negotiations paradigm in which the focus of contention became sharing the global carbon emissions cap among countries, leading *de facto* to somewhat rhetorical invocations of the sustainable development perspective of the UNFCCC.

Following the failure to reach a global agreement between COP 1 (in 1995) and COP 6 (in 2000), several different reasons were offered (see Aldy & Stavins, 2007; Barrett & Stavins, 2003; Keohane &

Victor, 2010) as to why such a paradigm would hinder the completion of the Kyoto Protocol's 'unfinished business' (Jacoby, Prinn, & Schmalensee, 1998). The major reason for this was that unless a global climate agreement is linked with the broader reforms of development assistance and finance, it is fundamentally unable to untie the Gordian knot tying climate and development (Hourcade, Shukla, & Mathy, 2008). Although developing countries were exempted by the Kyoto Protocol from any commitments to limit emissions, a global cap-and-trade system ideally needs universal participation; this is therefore the challenge of the second commitment period of the Kyoto Protocol.[2] The problem is that the grandfathered emissions allocation, adopted *de facto* at Kyoto, confers the bulk of emissions allowances to developed countries. This leaves little room for emissions quotas to developing countries that are slack enough to trigger financial transfers sufficient to compensate for the adverse effects of a unified global carbon price (Ghersi, Hourcade, & Criqui, 2003).

Since the inception of the climate change negotiations, the real-world dynamics have been at variance with the conditions needed for an agreement on the allocation principles. Economic globalization after the Cold War erased expectations for a new global order, although views about this were not readily reconcilable. This divergence in views arose from the existence of very different historical development paths and future development prospects (Shukla, 2005), which included rapid growth in incomes in emerging countries. This rapid growth shifted the basis on which nations were sorted (in 1992) into Annex I and non-Annex parties. At the end of the George W. Bush Jr administration, the Bali Road Map was supposed to capture the outcomes to be reached at Copenhagen (in 2009) on forestry measures, technology transfer, and an adaptation fund (UNFCCC 2007). However, even the presence of political leaders at the very highest level failed in Copenhagen to allow a binding agreement on emissions reduction commitments to be secured. Typically, the climate change negotiations offered little to alter the trends (e.g. of China building one coal power plant every week). The financial crisis served only to exacerbate the gridlock further.

For these reasons, the Cancun Agreement called for a paradigm shift towards building a low-carbon society 'that offers substantial opportunities and ensures continued high growth and sustainable development' (paragraph 10). The challenge can be caricatured this way: the 'climate centric' paradigm focusing on 'burden sharing' and 'property rights entitlement' is to be replaced by a 'development-centric' paradigm focusing on redirecting development patterns over the century while altering global emissions trends.

Times have changed since 1992. The formation of the BASIC (Brazil, India, South Africa, and China) block, which represents the interests of emerging economies, changed the global political dynamics. Typically, India proposed an International Consultation and Analysis rather than a strict requirement (needed for cap-and-trade) that emissions be measurable, reportable, and verifiable, and the principle of equitable access to sustainable development rather than the 'equitable right to atmosphere' that had besieged the North–South dialogue over the past two decades.

This paradigm shift presupposes a search for Pareto-improving policies, but does not dispose of the questions of equity and historical responsibility, which are to be reframed from the perspectives of reshaping economic globalization and of a universal solidarity ethic. This goes beyond the climate public good and encompasses the subtle rebalancing of the world economic equilibrium (Lecocq & Hourcade, 2010). The carbon price will help to reshape the landscape, but will certainly not be its sole instrument.

The only commitments of Annex I countries is that they must mobilize US$100 billion a year by 2020 and transfer technology and finance through the CDM by offsetting Assigned Amount Units

(AAUs). However, how to mobilize and utilize these funds is far from clear. There is still no consensus on the measures listed by the High-level Advisory Group on Climate Change Financing (AGF, 2010), which are to be funded by a levy on the revenues from auctioned allowances for international aviation and shipping emissions, levies on credit trades, carbon taxes, and financial transactions taxes.

The current adverse timing context should be recognized. First, the return of 'depression economics' (Krugman, 2009) can only exacerbate 'donor fatigue', as demonstrated by the difficulties of the Eurozone countries to rescue Greece. Second, public opinion in developed countries is sensitive to the fact that the dividing line between the rich and the poor no longer coincides with the traditional North–South division (Chakravarty et al., 2009). Examining how climate finance can nevertheless be made palatable for both developing and developed countries thus demands a prior understanding of what the policy parameters are that are likely to direct these countries towards 'brown' or 'green' development.

3. Policy choices behind the bifurcation between brown and green development

In order to secure a clearer understanding of the policy parameters that affect the green or brown nature of a country's development, two published modelling exercises are considered, which, despite their differences in methodology and data assumptions, deliver similar insights.

The first exercise was conducted using a soft-linked modelling system (Shukla, Dhar, & Mahapatra, 2008) for India, and is composed of a bottom-up national-level MARKAL model in which the energy investments are planned optimally, and is aligned with the global economic signals from the Global Change Assessment Model (GCAM) (Clarke et al., 2007), which generates a world equilibrium pathway (Shukla & Chaturvedi, 2011, 2012). The second exercise, using IMACLIM-R[3], is a recursive general equilibrium model of the world economy (Hourcade, Crassous, & Sassi, 2006). Its hybrid nature makes it possible to endogenize both technical change (within the limits of explicit asymptotes on energy efficiency and energy supply) and transitory disequilibrium (due to the interplay between technological inertia, the functioning of labour markets, and imperfect foresight).

Both models describe a business-as-usual scenario that incorporates current trends in energy efficiency and gives a significant role to nuclear energy. The growth pathway for the Indian model was calculated with exogenous economic and demographic growth rates (Shukla & Dhar, 2010), while in IMACLIM, a convergence of labour productivities was assumed in world regions across the century.

Both models also describe alternative sustainability scenarios (these will be referred to as the 'Sustainable LCS' scenarios. In the Indian model these were based on technology policies, including energy-efficient devices, 3R (reduce, reuse, recycle) measures, infrastructure choices, and the announced targets for solar power in 2022 in India's National Action Plan for Climate Change (GoI, 2008). In IMACLIM, town and country planning, together with shifts in the modal structure of transportation investments, allow for lower growth of freight transport and personal mobility.

In both scenarios, a carbon price was introduced to meet a 2 °C stabilization target and the revenues of the carbon prices were recycled in a lump-sum fashion (these will be referred to as the 'Conventional LCS' scenarios). There was no carbon trading in the Indian scenario, but in IMACLIM, carbon trading was modelled using works under a contraction and convergence rule. In the Sustainable LCS scenario, the Indian exercise added some complementary non-price measures and computed the domestic

shadow price of carbon necessary to meet the same carbon mitigation objective as in the Conventional LCS scenario. (This price is distinct from the world carbon price, which is not important because there is no carbon trading.) In IMACLIM, the revenues of the auctioned permits were recycled to partially offset the macroeconomic costs of a higher energy price, and policies were introduced to enhance the capacity of the labour force to move into new types of activities. The world carbon price was different from the carbon price in the Conventional LCS scenario because all countries were assumed to apply the same policy.

In the Indian model, the carbon price increased gradually, reaching \$202/tCO_2 and \$110/tCO_2 in 2050 in the Conventional LCS and Sustainable LCS scenarios, respectively. In this model, decision makers anticipated the long-term prices, and the carbon price paid by agents at each point in time was effectively lower. This was not the case in IMACLIM, in which high price signals are necessary over the short term to change the behaviour of semi-myopic agents (\$120/tCO_2 in 2030). This leads to learning-by-doing mechanisms in residential, industrial, and power sectors, which stabilized carbon prices up to 2050. Once these sectors were deeply decarbonized, a steady increase in carbon prices was again necessary (\$600/tCO_2 in 2100) to extract additional carbon savings. Because of the low fuel price elasticity of mobility demand, moderate carbon prices failed to induce the construction of energy-efficient urban and transport infrastructures before 2050, resulting in high gasoline demand. High carbon prices were then needed to control it and to compensate the rebound effect of energy efficiency gains (Herring, Sorrell, & Corporation, 2009). In the Sustainable LCS scenario, early investments induced lower mobility demand, and energy-efficient and low-carbon infrastructure was selected, delivering the equivalent low-carbon target at a relatively lower carbon price of \$380/tCO_2.

The resulting gross domestic product (GDP) losses (see Figures 1 and 2) were similar in order of magnitude, but not in time profiles. In the Conventional LCS scenario, the Indian exercise found 4% and

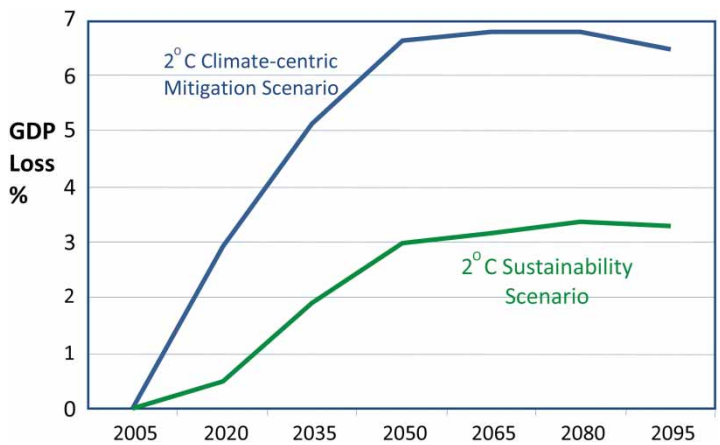

Figure 1 GDP variations in Indian low-carbon scenarios: GCAM-IIM model results

Source: GCAM-IIM model 2 °C scenario assessment for the present article. For GCAM-IIM scenarios assessments see Shukla and Chaturvedi (2011, 2012).

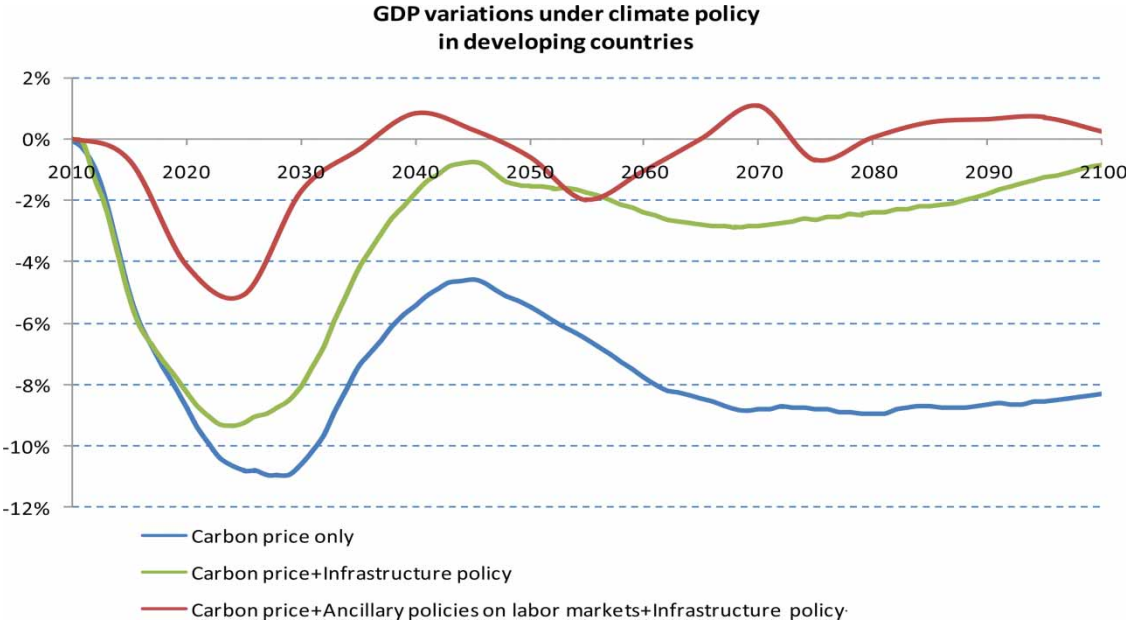

Figure 2 GDP variation for developing countries
Source: IMACLIM model results.[15]

6.5% GDP losses in 2030 and 2050, respectively. The world scenario, with higher short-run carbon prices, found an 11% GDP loss in 2030 for developing countries due to the higher carbon prices in the short run[4], but a similar 6% GDP loss in 2050. In the Indian Sustainability LCS scenario these losses were reduced to 1.7% (in 2030) and 3% (in 2050); the transitional losses were significantly reduced in IMACLIM, with a peak of 4.7% GDP loss for non-Annex I countries (oil-producing countries included) and an oscillation of small losses and gains after 2035. Oil-importing countries such as India even experienced a gain due to the lower vulnerability to oil prices, fostered technical change, and the revenues from carbon trading. In the Conventional scenarios, these revenues did not offset the adverse impacts of high carbon prices.

These results show the importance of Nationally Appropriate Mitigation Actions (NAMAs). These actions are not specifically devoted to carbon abatement, but are measures adopted for reasons other than climate objectives. NAMAs contribute to a lower carbon content in a number of development patterns: infrastructure and housing policies conducted to prevent energy poverty traps for commuters in the suburbs due to housing costs and the 'gentrification' of downtown areas; fiscal reforms based on carbon taxes; and programmes to upgrade the energy efficiency of appliances and national cooperation for managing hydropower potentials (Shukla, Garg, & Dhar, 2009). More fundamentally, the energy markets are surrounded by failures in other markets such as real estate, labour, land, capital, technology, and know-how markets. Economists are aware that several reform measures are needed to remove these failures (Fischer, 2008; Fischer & Newell, 2008). Measures aimed at broad macroeconomic and social objectives must be selected such that they are aligned with decarbonization objectives. The

notion that climate policies must have co-benefits is thus turned upside down: climate mitigation becomes a side benefit of specific development policies.

The above simulations show a possible bifurcation into two long-run equilibria, which are almost equivalent in terms of GDP but very different in terms of carbon content. However, no uncertainty is assumed about the evolution of the carbon regulatory regime and technology innovations. Moreover, the models use levelized costs to rank technologies in merit order, which implies unlimited access to capital. However, there is no such thing as unlimited access to capital in the real world. Infrastructure decisions involve high up-front costs (e.g. for purchase of equipment) as well as the transaction costs of diverse regulatory measures. These decisions will respond to 'marginal incentives' in the same way as carbon prices only if the investment risks are totally covered.

4. Carbon finance and beyond: triggering a confidence circle

Using climate finance to redirect up-front investment towards low-carbon infrastructure departs from the additionality principle, which has been used since 1992 by the Global Environment Facility for financing projects. This principle states that environmental funds should only pay the incremental cost of environmentally sound projects. The aim of the principle has been to ensure that such funds are counted in addition to overseas aid and not diverted to other purposes.

A problem with this principle is that it excludes projects with 'negative' or 'almost zero incremental' costs, and such projects comprise the majority of possible projects (Neuhoff et al., 2009). Actually, this principle assumes that the bulk of profitable projects have already been funded or will be funded anyway; thus it concentrates climate finance on the less attractive ones. This is one reason why the leverage ratio for the private investment of public finance mechanisms (PFMs) dedicated to low-carbon projects (LCPs)[5] is lower than that usually observed ($2–4 for every $1 of public money, compared to a $3–15 range for traditional PFMs; see AGF, 2010; Maclean, Tan, Tirpak, Sonntag-O'Brien, & Usher, 2008; Ward, Frankhauser, Hepburn, Jackson, & Rajan, 2009).

However, one major concern is that dropping the additionality principle may lead to windfall profits if international support were given to projects that would be adopted anyway (for reasons unrelated to climate change). The response to this legitimate concern has to be found in related to the political economy of the links between domestic policies and international governance. Activities involved in sectors such as energy, transportation, building, agriculture, and forestry depend on interlacing public policies and private initiatives. These depend on the particular political equilibrium of a country, region, or city. Changing this equilibrium is one of the key difficulties of enforcing Pareto-improving policies (Stiglitz, 1998) and demands a domestic political will. This political will must be accompanied by the capacity to pay compensation to entrenched interests so as to weaken their reason for lobbying and conserving the status quo. The role of international support is to help pay this compensation and legitimize the adoption of those policies (among alternative Pareto-improving policies) that are conducive to low-carbon development.

It is unlikely that an international cap-and-trade system will provide such assistance because the cash flows will be dependent on the demand for carbon offsets by countries that are subject to emissions commitments (this is the main cause of current uncertainty). As the CDM experience shows, carbon cash flows enhance the levelized benefit–cost ratio of LCPs, but cannot overcome the barriers

to up-front investments. Carbon cash flows are generated only when emissions reductions are observed, well after the start of a project (De Gouvello & Zelenko, 2010). This problem is extreme for infrastructures, which require large up-front investment and are subject to carbon benefits accruing over decades.

Climate finance should pay these up-front costs, but scaling it up is subject to a 'double-bind' situation. The circle of distrust between Annex B and non-Annex B countries, which inhibits progress in setting up the mechanisms that deliver carbon prices, must be broken. However, in the absence of carbon prices, a bilateral PFM initiative or proposal (e.g. a tax on bunkers or aviation) may look like a symbolic gesture and lead to fragmented assistance.[6] How then might this double-bind be broken? LCPs are confronted with the usual risks of all development projects: technical and regulatory uncertainties, currency risks, long payback periods, and volatility of market prices. They also face specific risks such as higher up-front costs of capital-intensive equipment and lower maturity of technologies (Grantham, 2009). It is not, however, important whether the total risk-adjusted cost of these projects arises from lower 'usual risks' or from 'carbon-specific' risks. The real problem, in a financially constrained context, is the extent of the finance that is needed to redirect the bulk of development projects instead of covering only their incremental costs.

The obstacle is not macroeconomic in nature: the $264–563 billion of up-front financing needed by 2030 (estimated by World Bank, 2009) does not primarily consist of additional investment costs.[7] It has been estimated (IEA, 2009) that, for a 450 ppm GHG concentration stabilization scenario, these additional costs amount to a significant but affordable 3% of total gross fixed capital formation (GFCF) or 0.6% of world GDP. The higher investment costs of low-carbon technologies are partly compensated by lower energy demand (due to higher energy efficiency and changes in consumer behaviour).

Transferring 0.6% of the world's GDP to LCPs might not even represent a proportional sacrifice of consumption[8] if it is in part achieved by correction of the actual direction of savings. Considerable savings are available from developed countries' pension funds, from rental revenues (oil, gas, real estate, and land), and from the high saving rates of emerging economies. In the last two decades, a proportion of these savings has been steered towards speculative investments and has nurtured a succession of investment bubbles, one of which was the real-estate bubble that ended with a large number of unsold or 'resold at a loss' buildings in the US, Spain, and several other countries.

Thus, carbon finance is a potential component of the solution to the financial crisis and can secure sustainable growth recovery in OECD countries and the rest of the world. Currently, the risky private and public debts co-exist with an excess of funds. This is a saving glut (Zenghelis, 2011) caused by a form of 'Buridan's ass' syndrome[9]: in a very uncertain world, the saver does not know where to invest in production where there are high-risk-adjusted returns, and hence refrains from investing in production at all. In contrast to the ass, however, the saver does not starve to death and indeed speculates. A climate-friendly financial architecture could alleviate this condition by enhancing investors' confidence[10] in LCPs and reducing the attractiveness of speculative investments.

Suppose that a future COP agrees on the social cost of carbon (SCC), i.e. the present value of carbon growing at a pre-determined rate over a given period. Although there is a very large range for this value in the literature, from $3/tCO$_2$ to $95/tCO$_2$ (IPCC, 2007) in 2030, it is worth noting that the UK, US, and France have already integrated an SCC into a regulatory analysis of public investments. (Their 2030 values are, respectively, $42, $33, and $130; see Clarkson & Deyes, 2002; Quinet, 2008; US DoE, 2010).

The choice of this value is political in nature. Coming to an agreement about it or this value be easier than finding consensus on the carbon price implicit in a cap-and-trade system, because the SCC acts as a notional value for long-run investments without entailing direct costs today for private agents.

If the SCC was integrated into projects' appraisals, it could act as a surrogate for a carbon price by tilting the balance in favour of LCPs by means of a reduction in their risk-adjusted costs. This would avoid the fragmentation of climate finance. As it increases with time and compensates for the role of the discount rate, the SCC would also help recognize the value of the carbon abated by infrastructure investments with long maturity. Enforcement of the SCC into the valuation of projects would require an independent supervising authority like in the CDM to decide allocation rules by type of project, to certify them, and to monitor their conformity to the initial plan.

A new class of assets could thus be created, on a voluntary basis, by the Central Banks of willing Annex I countries[11]. The development and investment banks could use this new asset to back the LCS projects through carbon certificates equivalent to the carbon that could be saved over a project lifetime. The asset value would be the expected cash flows that result from a number of conventionally allotted certificates valued at the SCC. Banks would receive these certificates in proportion to the LCPs they fund through loans at preferential rates.

The advantage of this carbon-based liquidity is that it would not be used by the banks only to restore their balance sheets, but instead would be used to fund the economy, which is in stark contrast to the large liquidity injections operative in the US and the Eurozone in 2010–2012. To help banks to comply with prudential rules when lending to LCPs, the carbon certificates could even be accepted as a legal reserve (like gold) or carbon equities *ex post* the certification of the level of conformity of the projects by the supervising authority. Thanks to the strong public guarantee of carbon assets, banks could then issue 'carbon coloured' financial products that aim to attract domestic savers (including those motivated by ethical objectives) at a rate that marginally exceeds that of existing safe deposits.

Any system built around such basic principles[12] would not revive a risky commerce of promises, as it would be liable to create something of value in the form of low-carbon infrastructure and avoided climate damages. It could trigger a long wave of 'green growth' recovery (Aglietta, 2011; UNEP, 2010) without creating new excess rights on future wealth (i.e. inflation).

One legitimate question is whether this proposed upgrading of climate finance would be equitable and in conformity with the notion of 'common but differentiated responsibility' of the UNFCCC. Technically, it does not formalize a North–South transfer, but rather redirects world private savings, including those of emerging economies. A first response is that because 60% of the carbon savings investments would occur in developing countries (World Bank, 2009), the net flow will in fact be North–South. A second response is that a share of the newly issued carbon assets could contribute to the Global Climate Fund supplemented with small innovative taxes (e.g. on financial transactions, international shipping, and aviation sectors). This fund could then issue highly rated 'carbon-based' bonds to finance LCPs.

However, a better response is that the proposed system would be effective in delivering equitable access to sustainable development and extends the notions of responsibility and respectability. The sustainability of the development in the South might be weakened by climate change over the long run, but, in the short and medium term, also by the manner in which the debt crisis is solved in the North. The financial crisis – caused by the financial and monetary policies of the West over the past thirty years or so – currently hurts developing countries in terms of financial flows, trade flows

(through the contraction of growth in the OECD), and employment. Developed countries thus bear the responsibility of seizing the financial crisis as an opportunity to re-build old financial institutions (e.g. the International Monetary Fund (IMF)) and financial North–South partnerships.

Annex I countries could assume their dual responsibility and financially back the carbon savings projects and policies. They would thus bear the risk of the regulatory uncertainty of climate policies and launch a process that could, ultimately, lead to the existence of New Special Drawing Rights at a reformed IMF. This would lower the price of the Credit Default Swaps for countries that invest heavily in carbon saving infrastructure.[13]

In addition to lowering geopolitical tensions (energy security, climate refugees, and local political instability), redirecting a part of the savings of emerging economies domestically would contribute to a pacification of the current anxiety about currency rates and eventually achieve a more even balance between export-led and inward-oriented growth. It would help to reduce one of the major structural imbalances of the world economy, i.e. the disparity between the saving/consumption ratios of the US and China (and soon of a few other emerging economies), which generates both huge capital flows from the latter to the former and trade patterns that undermine part of the industrial system and the social contract in many countries. It could also facilitate the re-investment of revenues from fossil fuel-exporting countries and help them affirm the sustainability of their development beyond the 'oil and gas' era.

5. Conclusions

One of the risks after Durban, given the difficulty in building a 'Grand Architecture' (Bodansky, 2003), is falling back into a so-called 'favella' regime (Jacoby, 2005), i.e. a self-organizing process. Unfortunately, favelas have turned more often into self-reproducing pockets of violence, slavery, and poverty than into innovative urban settlements.

The mechanisms of the Kyoto Protocol under Articles 6, 12, and 17 are at risk because they lead to negotiations based on a burden-sharing paradigm. The EU Emissions Trading Scheme, Joint Implementation, and Clean Development Mechanism have created tradable rights (Emission Reduction Units, Assigned Amount Units, Certified Emission Reductions, respectively) and can play a role at local, national, or regional levels to deliver carbon prices for these rights. However, these are inadequate to shift current decision patterns in the infrastructure sectors in time to avoid lock-ins into carbon-intensive development pathways (Shukla & Dhar, 2010).

Two parallel modelling exercises have demonstrated the orders of magnitude of carbon emissions mitigation that could be yielded by investments governed by criteria other than climate change, and have shown that these are even higher than the contribution from the sole carbon price signal. These exercises also show that making these investments more attractive than other investments, including speculative investments, substantially lowers the social cost of a carbon constraint and provides a basis for the paradigm shift at Cancun that called for an alignment of climate objectives and development policies. Upgrading climate finance is key to securing such a shift. Using carbon finance as part of the broader reform of financial systems and overseas aid is vital to overcoming both the dual adversity of climate and financial crisis contexts, and minimizing the risks of dynamic inconsistency in national climate policies.

A system has been proposed in which an agreement on SCC could support the issue of carbon certificates by the banking system in order to reorient a significant part of world savings towards low-carbon investments. This proposal, to be worked out in more detail in a future article, could enshrine a principle of equity in a global deal that would do much to dispel the current concerns arising from an overemphasis on burden sharing, and could also generate trust. By giving carbon assets the status of a reserve currency, the system could even respond to the need of emerging countries to diversify their foreign exchange reserves[14] and trigger a wave of worldwide sustainable growth through infrastructure markets, as occurred with the Marshall Plan in the aftermath of the World War II.

With the proposed approach, the questions of equity and responsibility no longer boil down to an issue regarding 'who pays for a given burden' at the margin of a system. In the spirit of the recent Rio declaration on 'The Future We Want' (UN, 2012), the proposed system focuses on the equitable nature of 'a common future', one that is to be built on a shared vision of risks, responsibilities, and equity.

Notes

1. The Durban conference replaced the notion of 'legally binding' commitments on emissions caps with the weaker notion of 'outcome with legal force'.
2. This motivated the Indian veto, on behalf of G77 + China, of an agreement at Kyoto between the EU and the JUSCANZ (WEOG subset) group on the modalities and rules of carbon trading: 'There will be no emissions trading until the question of the entitlement of primary emissions rights is resolved' (G77 & China, 1997).
3. In IMACLIM, the world economy is disaggregated into 12 regions and 12 sectors. For a more detailed description of the structure of IMACLIM, see Sassi et al. (2010).
4. Developing countries are more adversely impacted than developed countries by high carbon prices because of the lower energy efficiency in industry, a higher share of fossil energy in the energy mix, a higher share of energy in households' budgets, and a higher share of energy-intensive industries in a catch-up development period.
5. LCPs have been developed by organizations such as the Global Environment Facility, Special Climate Change Fund, Climate Investment Fund, Clean Technology Fund, and the Carbon Partnership Fund.
6. The costs of fragmentation are underlined in the Paris Declaration on Aid Effectiveness and in the Bali Action Plan in the case of overseas aid mechanisms (OECD, 2005). One symptom of distrust in relation to climate finance is the refusal of developing countries to treat climate grants as aid, the purpose and destination of which is to be determined by the donor. Another symptom is the failure of the International Civil Aviation Organization and the International Maritime Organization to take action. This prompted the EU to take unilateral action to provoke an agreement for international action. However, many emerging countries have perceived this initiative as a protectionist measure.
7. For a discussion of the incremental costs of LCPs, see Olbrisch, Haites, Savage, Dadhich, and Shrivastava (2011).
8. See Foley (2009) on the possibility of avoiding a tradeoff between present consumption and the future climate.
9. Buridan argued that it is wise to postpone any decision until all the necessary information is available, a view caricatured by 'Buridan's ass', a tale of a donkey who starves to death because it has no reason to choose between two equidistant piles of hay.
10. Enhancing this confidence also implies that there will be better quality control of 'clean' projects after a period involving a social learning process.
11. This could include the European Central Bank. For more on the link between carbon finance and the Euro crisis, see Hourcade and Aglietta (2012).

12. For a more in-depth technical description, see Hourcade, Perrissin Fabert, and Rozenberg (2012).
13. Analyses of the climate-friendly reforms of the overall financial system are still in their infancy (see Bredenkamp & Pattillo, 2010; Hourcade et al., 2012).
14. The governor of the Central Bank of China, Xiaochuan Zhou, has called for worldwide reflection on an international reserve currency that is anchored to a stable benchmark, and has argued in favour of reformed SDRs.
15. Graph derived from simulations presented in Waisman, Guivarch, Grazi, and Hourcade (2012).

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